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CONSTRUCTION CASH FLOW AND RISK S-CURVES DEVELOPMENT APPROACH, AND AREA METHOD ANALYSIS AT THE PRECONSTRUCTION STAGE FROM CLIENT PERSPECTIVE IN THE UNITED ARAB EMIRATES

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Abstract

Purpose – Understanding construction cash flow estimation is crucial for project success. Experts are concerned about project's cash-flow and risk estimation and control. Latest construction studies concentrated on modelling and estimating construction costs and risks.

Methodology – This article aims to approach pure quantitative mathematical modelling to develop the S-Curves (i.e., cash-flow and risks) and to develop the cash-flow simple area method. This research referred to the mathematical definitions of construction cash-flow and risks, integrating a clear systematic approach to develop the s-curves and to build the simple-area-method.

Findings – This research paper reviled that construction cash-flow and risk s-curves can be developed at the preconstruction stage, mathematically, without the need for having cost historical data of similar completed projects. In addition, this article has provided a simple area method approach mathematically, for construction cash flow analysis, using the basic developed cash-flow s-curve and the actual cost data of, at least, 2 completed similar projects. The simple area method is proved effective to provide a better understanding of cash-flow behaviour of the analysed projects' type. However, the s-curves development can be generalised to cover construction cost and risk simple s-curves, while the area method is restricted with the projects' characteristics (i.e., type, size, location, etc.) used in developing the simple area.

Unique contribution to theory, practice and policy – The significance of this study is to provide an S-Curve development approach for both cashflow and risk percentages from client perspective at the preconstruction stage, using solely the tender contract value. And to provide a simpler stochastic area method approach for project management professionals/researchers, who do not have large amount of historical similar projects' cost data. Originality, theoretical-implications, practical-implications, and limitations are presented in the conclusion for future research.

Keywords: *Construction, Cash Flow, Risk, S-Curve, Area Method Approach, Cost Estimation.*

1. INTRODUCTION

In this article, construction cash flow and risk s-curves will be developed at the pre-construction stage following simple logistic s-curve requirements and guidelines. Then, it will develop a new construction cash flow area-method approach. This is important due to its extreme need for modelling and analysing

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costs and risks. Finally, this article will conclude with the findings and recommendation for future research.

2. LITERATURE REVIEW

In this part of the article, the need for further construction cost and risks research is presented systematically. It is found mandatory to deliver an approach for creating construction cost and risk s-curves behaviours at the pre-construction stage. However, the problem-statement, aim and significance are detailed to provide clear understanding of the analysis, findings and conclusion parts of this research paper.

2.1. The Need for Construction Cost Cash-Flow and Risks Quantitative Analysis

Although risk quantitative management and analysis are ignored, they are essential to predict its costs and impact on planned time, performance, and budget of construction projects (Poh & Tah 2006). So, it is imperative and valuable to identify and assess possible known risks and predict the unknown risks in projects at the pre-construction stage (Schieg 2010). This will avoid cost overrun due to waste of time or resources; however, researchers proved that risk factors and variables are major and required to be considered while integrating and analysing construction cost models (Schieg 2010). For more than 40 years, these factors and variables of industrial businesses' risks are projects’ concerns for project managers and operations managers (Seshadri & Subrahmanyam 2005). However, the risks and cost statistical and mathematical equations are the best way to measure and evaluate the financial and non-financial assets’ risks impact on predicting costs (Hernandez-Sancho, Molinos-Senante & Sala-Garrido 2011). In other words, the relationship between costs and risks has been proved by researchers that costs and time impact risks; however, vice versa connection of variables’ sets did research in cost estimating and modelling take into consideration risks from identification stage to assessment stage using integrated models (Doloi 2012). In 2010, researchers started to develop and compare cost modelling of constructions to reach more accurate solutions using mathematical equations for a précised value before executing projects (Petroutsatou & Lambropoulos 2010). Researchers' models covered fuzzy techniques for reasoning and analysing construction risks to take and implement appropriate decisions (Zeng, An & Smith 2007). These fuzzy modelling of risks opened the door for more appropriate methods and approaches to analyse risks with the other factors and categories such as system dynamics (Nasirzadeh, Khanzadi & Rezaie 2013). Therefore, cost modelling and its interaction with risks must be considered based on the latest empirical research studies. The latest tools and results of modelling costs and risks in the construction industry, according to scientific journal publications required the highest possible inputs accuracy of the developed cost model. This is including accurate construction increasing cash-flow s-curve behaviour and accurate construction cost-risks decreasing s-curve behaviour.

After that, risks lead to extra costs in the construction industry due to improper assessment processes or misidentifying some of the critical risks; so, variables of risks are impacting estimated budget accuracy significantly when they cause changes in costs of construction execution (Ali & Kamaruzzaman 2010). This is proving the strong connection of construction cash-flow and risks mathematically. This research paper will provide, in percentage, the behaviour of each s-curve time step for both cash-flow and cost-risks. Nevertheless, most of the time, risks are identified and assessed to provide the proper performance of the project delivery processes; thus, performance variables are considered critical projects cost modelling (Ali

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& Kamaruzzaman 2010). According to some researchers, costs mathematical modelling in building construction projects, optimises estimated results when related to risky components such as time, waste, and energy (Abanda, Tah & Cheung 2013). It was also proposed to model costs against an important criterion such as the cost impact of risky variables over time (Abanda, Tah & Cheung 2013). This was done by integrating and designing a set of equations required to get better results (Abanda, Tah & Cheung 2013). Cost modelling in public-private partnership construction projects is considered a big challenge that has to be eliminated or minimized for more accurate financing and funding without facing challengeable obstacles. However, these obstacles may lead to delay or fail projects at the execution stage (Akinyemi et al., 2009). In order to solve risky cost decisions, it was found in research that most construction practitioners and professionals such as project managers use "Cost-Effectiveness Acceptability Curve" (CEAC) for appropriate and optimum decisions. For instance, the percentage of using the (CEAC) has increased from 2.1% to 32.6% between 2001 and 2006, proving its efficiency and deep connection between risk and cost in projects (Maiwenn 2013, p. 93). This is the reason, in this article, behind using percentages of the total construction cost rather than using a cost value each timestep. Moreover, regarding construction risks and cost overrun, it is popular that structural elements and other components make people over-design the engineering component for reducing risk while increasing cost significantly; however, cost-design optimization methods have been developed by researchers to solve risk-cost conflicts between management and technical professionals (Aldwaik & Adeli 2016). Therefore, it can be considered one construction project management cost modelling factors and variable (Aldwaik & Adeli 2016). Also, it is supporting this research paper to provide the developed s-curves in the pre-construction stage.

Next, form investigation conducted by researchers in the private and the public sectors, it was found that estimating and predicting cost modelling must cover construction industry risks when it comes to the financial decision starting from choosing contractors until delivering the project to the end-users by the client; however, this is because of the following: 1) the underestimate at projects pre-construction stage (i.e., tendering stage), 2) the overrun of costs during projects' execution, 3) the financial and funding constraints of appearing risks and claims made by projects parties (Ayangade, Wahab, & Alake 2009). This makes cost modelling accuracy extremely significant in the construction industry from the client's point of view (Ayangade, Wahab, & Alake 2009). Therefore, it is essential to cover construction cash-flow and cost-risks s-curve in this research modelling study.

One of the effective methods of analysing construction costs under the risks and uncertainty in developing a fuzzy approach and framework (Dikmen, Birgonul & Han 2007; Baloi & Price, 2003). This will help make an appropriate financial decision and estimation (Dikmen, Birgonul & Han 2007; Baloi & Price, 2003). The fuzzy framework has been discussed in several cost research papers and thesis. It can also be based on case-based approaches for cost estimate modelling scenarios through experience and hierarchy process combination methodology (An, Kim & Kaug 2007). It can be achieved by developing project costs predicting reasoning efficiency analysis (An, Kim & Kaug 2007). So, the dynamical modelling of risks in construction projects using fuzzy logic showed that system dynamics could identify and allocate risks at the early stages of executions while it can also help in eliminating unnecessary risks before experiencing its impact on costs, time, or performance (Wang, Ding, et al. 2016; Nasirzadeh, Khanzadi & Rezaie 2014). After that, risk modelling identified different reasons behind different pricing results for the same

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construction project processes and activities in different times and positions; for example, political, law, and international procedures risks as significant in modelling costs accurately (Cohen & Kunreuther 2007). However, it is essential to identify the most accurate costs of resources and activities during the project's stages (Eden, Williams & Ackermann 2005; Liu, Xu et al. 2012). This can be done through the outputs on this paper, including the developed s-curves. For example, the "Vector Autoregression" Model (i.e., VAR) proved that budgeting processes for long and short-term project operations have significant impacts on CCI "Construction Cost Index" stochastic forecasting (Xu & Moon 2013, p.10). So, the risks of changing the project schedule will significantly change its pricing, and the estimated costs and budget accuracy will change accordingly (Pajares & López-Paredes 2011; Mizell & Malone 2007). This is because of economics and policy conditions, which may change resource prices variations (Pajares & López-Paredes 2011; Mizell & Malone 2007). Therefore, the "earned value management," besides monitoring and controlling techniques, needs to be considered when scheduling processes to fix estimated budget as much as possible (Pajares & López-Paredes 2011, p.615; Mizell & Malone 2007).

Besides, researchers found out that it is crucial to model cost and time in mega construction projects such as tunnels (Isaksson 2002). However, the tremendous adverse effects of high risks and uncertainty of construction projects, such as infrastructure and tunnelling projects, are caused by over costs and delays resulting from an improper assessment of cost and time risks at pre-construction stages (Torp et al. 2016; Memon et al. 2010; Thijssen 2015; Isaksson 2002). These previous researches declared that cost estimation modelling is essential for megaprojects and investigated this importance validity using real projects data; therefore, this research study will investigating the applicability to create a dynamical area method with a number of projects less than 30 projects. Also, it is agreed that over costs in construction projects are happening because of several factors, including unfixed costs after fixing the budgets, finalizing tender documents, starting project's activities under inflation, which are changing actual costs from the expected budget (Isaksson 2002; Ong & Ong 1986; Toh, Ting, et al. 2012; Peng & Lai 2012; Zakis, Zakis & Arfridsson 2017). So, time and cost modelling of projects are significant because of its power to shape clients and contractors' decision-makers who are the most powerful and essential stakeholders in mega projects (Isaksson 2002; Acebes et al. 2013; Signor et al. 2016; Karim & Adeli 1999). As a result, this research study will investigate cost estimation accuracy in housing mega residential projects in the UAE. Besides, researchers concluded that research mathematical modelling and approaches, including cash-flow and risks s-curve simulating technique, is to maximize forecasting decisions accuracy (Isaksson 2002; Meyer et al. 2013; Matto & Sippola 2016; Kleyner & Sandborn 2008; Hamaker & Componation 2005; Sher & Punglia 2014; Shah & Goldstein 2006; Lee, Lee, et al. 2011).

In other words, the advantage of including cost overrun estimate calculations and time modelling mathematically from client and contractor perspectives is to help in making better decisions regarding tender budget and pricing; however, studies found that the "construction-contracting" method can consume and waste too much time and money during project execution stage (Isaksson 2002, p.9; Hu & He 2014; Jrade & Lessard 2015; Wilke 2005). Overrun and over budget uncertainties are high costs risks on contractors and clients (Isaksson 2002). Cost-time modelling has been proposed based on estimation and the practical modelling of projects' cost dynamics (Isaksson 2002; Zhu et al. 2007; Adey et al. 2012; Howell & Koskela 2000). This will help choose the method of executing the project which is critical and necessary

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to determine the time and cost modelling (Isaksson 2002; Koo et al. 2010; Battistoni et al. 2016).

2.2. Problem Statement

Researchers and professional experts are experiencing challenges in studying the impact of variables on construction cash-low and risks. This requires establishing a scientific simple s-curves behaviour without any additional impact on it.

2.3. Research Aim and Significance

This article aims to provide a systematic approach to develop construction cash flow and risks s-curves. These s-curves are covering a period of 3 years, while considering only 8 timesteps each year. This will ensure keeping the privacy of the original used data of the area method, which is based on 12 timesteps (i.e., 12 month). Then, a stochastic area method approach will be provided, which can be created with lower number of projects than what is required in the previous published research (i.e., ≥ 30 projects). This will help construction cost researchers and professionals to proceed with their analysis, although there is a challenge of having enough previous projects' data (i.e., ≤ 29 projects). The significance of this research is to provide the equations system and approaches required for deferent types of quantitative and mixed-method analysis. This can be used and fed into a wide range of software programmes dynamically over time. Finally, this research is providing the first stochastic cash flow area method if UAE housing residential building projects.

3. RESEARCH METHODOLOGY

This article is using pure mathematical equations system to develop the construction cost S-Curves behaviours (i.e., cash-flow and risks) and to establish a simple area method to estimate cash-flow behaviour. This research referred to the mathematical definitions of construction cash-flow and risks, integrating a clear systematic approach to develop the s-curves and to build the simple-area-method. The connection, between cost cash-flow and cost risks s-curves, is justified and proved mathematically to support the quantitative integration of project management future cost modelling and analysis for both researchers and industry professionals.

4. CONSTRUCTION COST S-CURVES AND AREA METHOD DEVELOPMENT

This article is using pure mathematical equations system to develop the construction cost S-Curves behaviours (i.e., cash-flow and risks) and to establish a simple area method to estimate cash-flow behaviour. This research referred to the mathematical definitions of construction cash-flow and risks, integrating a clear systematic approach to develop the s-curves and to build the simple-area-method. The connection, between cost cash-flow and cost risks s-curves, is justified and proved mathematically to support the quantitative integration of project management future cost modelling and analysis for both researchers and industry professionals.

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4.1. Construction Cash Flow S-Curve Development

Creating an s-curve in construction cost research is including three main approaches (Cristóbal 2017; Kucharavy & Guio 2014). The first approach uses historical related projects' cost s-curve to build the estimating model's s-curve (Cristóbal 2017). This is commonly used to ensure accurate estimation of similar projects after understanding and implementing lessons learned and best practices (Cristóbal 2017; Odeyinka, Lowe & Kaka 2013; Abanda, Tah & Cheung 2013; Ahiaga-Dagbui 2014; Kucharavy & Guio 2014). It will be based on measuring curve parameters from the actual project's cost curve data (Cristóbal 2017). These parameters are including 4 points to decide the behavior of desired s-curve (Cristóbal 2017). These 4 points will be substituting the α and T0 shown in equation 2 (Cristóbal 2017). The 4 points are extracted from the actual projects s-curve (i.e., time-cost curve) to include the data of 20%-point, 25%-point, 75%-point, and 80%-point (Cristóbal 2017). It is proved accurate in previous literature to draw s-curve accurate yield points and its growth (Cristóbal 2017). The second approach is by taking an s-curve equation related to the same project type of desired research and having the same duration to start estimating costs based on possible investigation scenarios (Cristóbal 2017; Odeyinka, Lowe & Kaka 2013; Abanda, Tah & Cheung 2013; Kucharavy & Guio 2014). This approach is accurate in modelling the researcher's investigation topics related to cost cash flow in the construction stage (Cristóbal 2017; Odeyinka, Lowe & Kaka 2013; Abanda, Tah & Cheung 2013; Kucharavy & Guio 2014). This research is modelling cash flow itself and will not completely follow previous researchers' s-curves. This is because other s-curves may have experienced factors that are not included in this research. Therefore, it may impact this research accuracy. The third approach is to have a standard simple logistic S-curve for the desired cash flow quantity over the desired project's construction duration (Kucharavy & Guio 2014).

Past research's output equations and integration provided valid Construction Cost S-Curve as shown in equations 1 to 4 (Cristóbal 2017; Odeyinka, Lowe & Kaka 2013; Abanda, Tah & Cheung 2013; Ahiaga-Daghui 2014; Kucharavy & Guio 2014). It agreed that the construction s-curve is following the logistic exponential s-cure shown in equation 1 (Cristóbal 2017; Odeyinka, Lowe & Kaka 2013; Abanda, Tah & Cheung 2013; Ahiaga-Daghui 2014; Kucharavy & Guio 2014). Researchers developed equation 1 to equation 4 for better performance in computing construction cash flow (Cristóbal 2017; Ahiaga-Daghui 2014; Kucharavy & Guio 2014). This will require certain requirements to be established according to Kucharavy and Guio (2014), as shown in Figure 1.

$$f(x) = \frac{1}{1+e^{-x}} \tag{1}$$

X is the time point on S-Curve chart

e *is* exponential constant.

$$f(x) = \frac{1}{1+e^{-\propto(t-T_0)}} \tag{2}$$

T_0 = The maximum slop adjusting parameter. The maximum slop increases as it increases.

t = The time step of f(x) cash flow point.

$$\begin{cases} \propto (t_1 - T_0) = \ln\left(\frac{1}{f_1} - 1\right) \\ \propto (t_2 - T_0) = \ln\left(\frac{1}{f_2} - 1\right) \end{cases}$$

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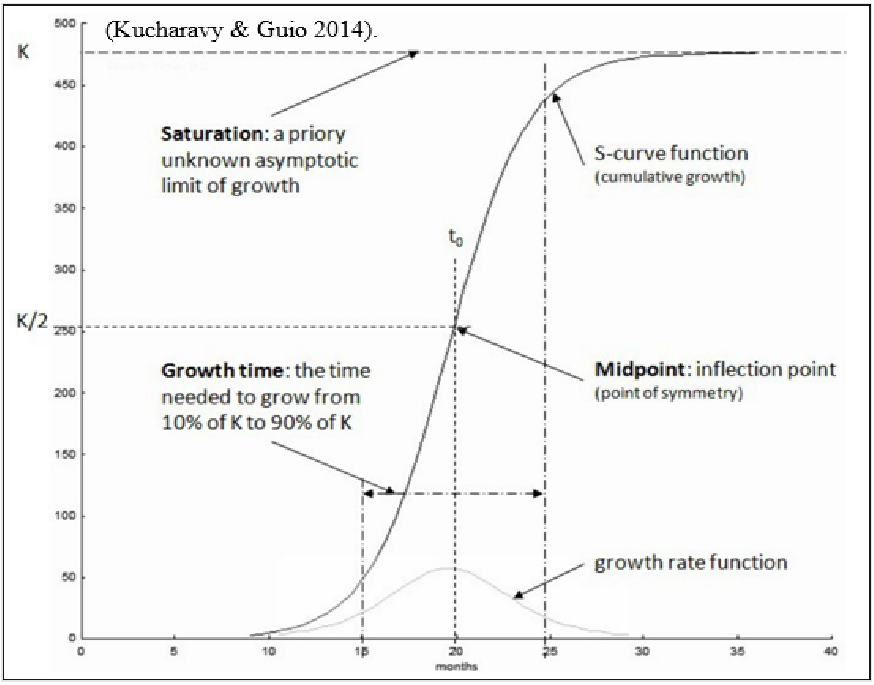
From similar literature:

$$f\,(X) = Cost\ \text{S-Curve} = \frac{1}{1+e^{-1.22(t-1.88)}} \quad (3)$$

Adapting for 3 years construction from similar literature based on 8 time steps per year:

$$f\,(X) = Cost\ \text{S-Curve} = \frac{1}{1+e^{-2.7(t-1.4)}} \quad (4)$$

Year Time Step	Cost Cash Flow Increasing S-Curve
Design Stage	0
0	0.022
0.125	0.031
0.25	0.043
0.375	0.059
0.5	0.081
0.625	0.110
0.75	0.147
0.875	0.195
1	0.254
1.125	0.322
1.25	0.400
1.375	0.483
1.5	0.567
1.625	0.647
1.75	0.720
1.875	0.783
2	0.835
2.125	0.876
2.25	0.908
2.375	0.933
2.5	0.951
2.625	0.965
2.75	0.975
2.875	0.982
3	1.000



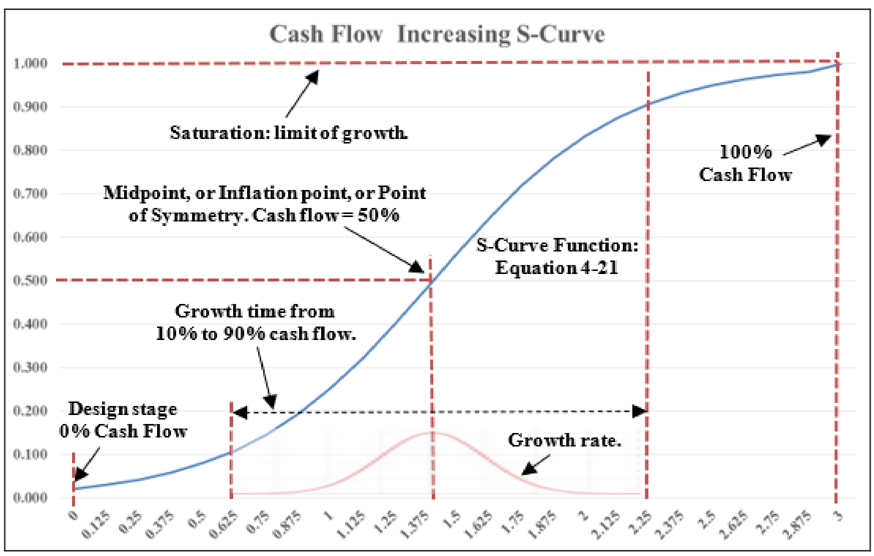


Figure 1. *Adapted figure showing fitting parameters: The final 8-timesteps S-Curve used in this research construction cost modelling based on literature guidance (Cristóbal 2017; Kucharavy & Guio 2014). However, K value represent construction cost of this research.*

There are three steps need to be satisfied to create a fitted simple estimating s-curve meeting actual data accuracy level (Kucharavy & Guio 2014). First, estimating the curve lower and upper limits (Kucharavy & Guio 2014). This research's lower limit starts from zero cash spent, and the upper limit is equal to 100% of project cash spent. Second, allocate s-curve fitting parameters, as shown in Figure 1 (Kucharavy & Guio 2014). This will include the growth time needed for costs to increase from 10% spent to 90% spent (Kucharavy & Guio 2014). Then, allocate the time midpoint where estimated costs reach 50% of total costs (Kucharavy & Guio 2014). Third, examine and reduce the actual-to-estimate residuals (i.e., data-to-model residuals) to ensure that the estimated s-curve reflects the actual estimated costs (Kucharavy & Guio 2014). Therefore, this research used previous construction equations to fit its adjustment parameter (i.e., α (t – T0)) to meet the literature's required fitting rules, as shown in Figure 1. Equation 4 is the final used equation is the cash flow S-Curve Model.

4.2. Construction Risk S-Curve Development

According to Oxford Advanced Learner's Dictionary (1995), risk definition is the possibility of suffering harm or loss; or facing danger or failure (Baloi & Price 2003). Therefore, it is challenging to generalize its measurement or its behaviour throughout projects. This mathematical modelling is deterministic because its answer has exact values. However, risks can be used for the study as long its definition can be met and satisfied through the assigned measurement or behaviour criteria (Baloi & Price 2003). Several facts need to be considered in order to finalize the construction risk equation. First, construction risk is taking an exponential function for costs and financial situations (Dowd & Cotter 2007). Second, construction (i.e., buildings) risk behaviour is based on a decreasing S-Curve (Pajares & López-Paredes 2011). Third, to satisfy the risk definition, the probability of facing danger during construction will be in the remaining time, and the amount of cash paid. These are the required risk behaviour considerations in this research cost estimation model. The conditional probability intersection relationship between two events is mathematically represented by multiplication (Techet 2005). There are two calculation parts of construction cost risks. The cash flow s-curve is based on time and costs ratio/percentage (i.e., X and Y). First, the probability of facing danger in time at each time step is the weightage of remaining time concerning total construction time. It will equal the ratio of time remaining to total construction time, as shown in equation 5. Second, the probability of facing danger in costs at each time step is the weightage of remaining costs concerning total construction cost. It will equal the ratio of remaining unpaid value to total construction cost. This can be extracted from Figure 2 and equations 6 and 7. In equation 8, limits function are important to show the exact calculations of CS as risk time step value (i.e., TS) approaches cash flow s-curve time step value (i.e., t). Construction risks are active from just before the first cash flow payment until the last cash flow payment. In other words, construction risks are 100% just before starting and 0% at the finishing time. Thus, the construction risk curve will equal the probability of facing risk in the remaining time multiply by the probability of facing danger in the remaining cash flow amount will equal to this research risk decreasing s-curve as shown in equations 8 and 9 (Pajares & López-Paredes 2010). Therefore, this research risk s-curve will equal to Figure 2 chart values. The probability of facing risk in remaining time multiply by the probability of facing danger in remaining cash flow will be this research Risk S-Curve as shown in equation 5 to 9 and Figure 2 (Pajares & López-Paredes 2010; Techet 2005; Dowd & Cotter 2007).

$$P_T = \frac{T_E - T_S}{T_E} = \text{Time Risk} \tag{5}$$

P_T is the probability of time danger.
T_E is the total execution time.
T_S is the risk time step value.

$$C_S = \lim_{T_S \to t} \left(\frac{1}{1+e^{-1.22(t-1.88)}} \right) \tag{6}$$

C_S is the cost S curve value at each time step (from 0 to 1).
t **is** the time step of f(x) cash flow point.

$$P_C = [1 - C_S] \tag{7}$$

P_C is the probability of cost danger.

$$P\,(Time\ Risk \cap Cost\ Risk) = P_T * P_C \tag{8}$$

$$\text{Risk S-Curve} = \frac{T_E - T_S}{T_E} * \left(1 - \lim_{T_S \to t} \left(\frac{1}{1+e^{-1.22(t-1.88)}} \right)\right) \tag{9}$$

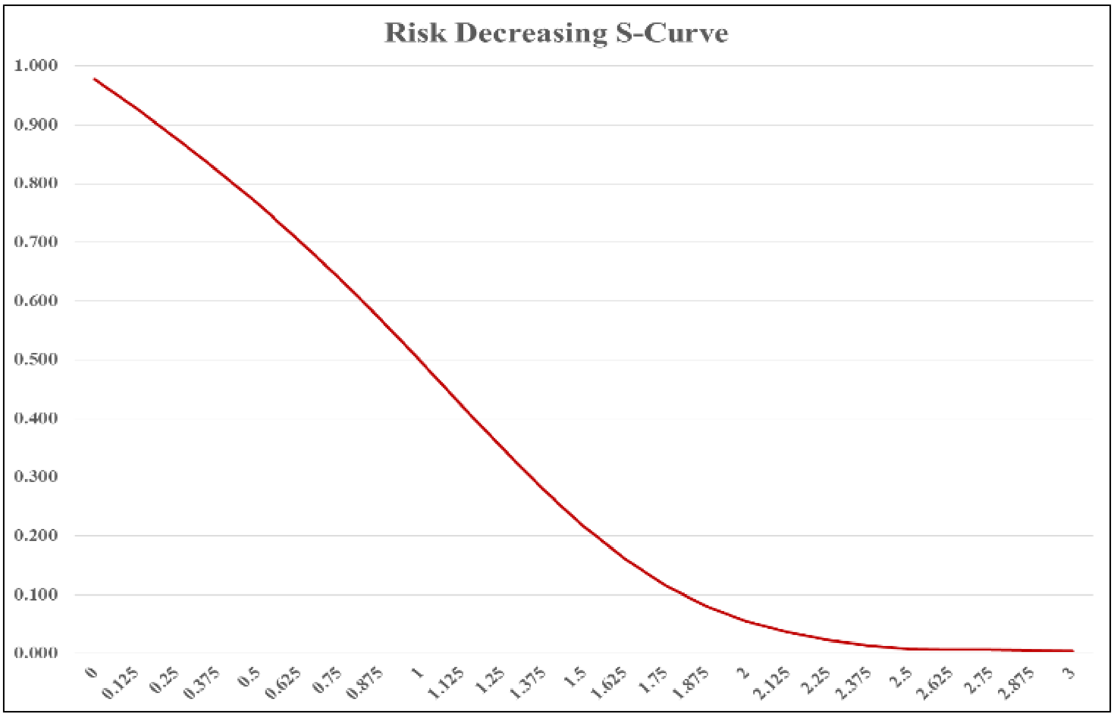


Figure 2. *Trending 8-timesteps construction Risk decreasing S-Curve.*

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4.3. Cash Flow and Risk S-Curves for 1 year to 5 years Construction Periods

In this part of the article, cash flow and risks s-curves are provided for construction phase including two scenarios. First, the construction stage which is ending by the project completion. This is an appropriate curve if the cost analysis is considering the retention bond instead of holding the actual cash during the defect notification period (DNP) / the defect liability period (DLP). Or, in case if the researcher / professional experts are investigating the cash flow of a project's whole life cycle; however, in this scenario, the operational expenditures will start directly after the project's completion and the retention amount will merge with the operational costs. Therefore, it is better to consider the retention behaviour like the retention bond behaviour of the construction phase cash flow s-curve. Retention bonds have been defined as an alternative process of the keeping the retention cash during the DNP/DLP stage (RICS 2012).

In figures 1 and 2, the 8-timesteps curves will be used in the following parts of creating the cost area method analysis. Nevertheless, tables 1 to 10 and figures 13 to 22, in the research paper are detailing the s-curves based on 12-timesteps for direct use by cost analysts. Both cash flow and risks s-curves are based on the perfect cash flow s-curves, which is following Kucharavy & Guio (2014) s-curves guidance.

Next, it is important to detail the s-curves tables' colour coding to understand how the provided data and plotted charts are satisfying the published s-curve criteria. Table 1is detailing the meaning of each colour code used in tables 2 to 11.

Table 1. *Identifying the colour coding used in tables 2 to 11.*

SN	Colour	Description	Details
1		The green colour	This green colour is used to identify the points which are satisfying the simple s-curve requirements as per the previous research guidance. This is including the time intervals and cash flow columns.
2		The yellow colour	The yellow colour is used to identify the construction completion points. The is including the time intervals, cash flow, and risk columns.
3		The light blue colour	The light blue colour is used to identify the civil DNP/DLP expiration point. This is including the time interval columns and the column titled expected cash flow s-curve based on down payment and retention.
4		The red colour	The red colour is used to identify the end of construction cash flow points, after construction completion and DNP/DLP expiration just before the end of the construction project.
5		The sky-blue colour	The sky-blue colour is identifying the risk's s-curve starting point which is inserted manually as the first point equal to 1. It is representing the risk status just before the first point where risk is equal to 100%.

Table 2. *Identifying 1 year construction Cash flow and Risk S-Curves based on accepting retention bond.*

Time Label	Month Interval (n)	Year Interval	Expected Cash Flow S-Curve Based on Down payment & Retention	Perfect Cash Flow S-Curve	Risk S-Curve
		"Month Interval (n)" * (1/ "# of time steps in a year (i.e., 12)")	1/(1+(EXP(-5.7*("Year Interval"-0.5))))	1/(1+(EXP(-10.6*("Year Interval"-0.5))))	((1 -"Year Interval (n-1)")/1)* (1-"Perfect Cash Flow S-Curve (n-1)")
Start	0	0.00	0.05	0.00	1.000
Month 1	1	0.08	0.09	0.01	0.995
Month 2	2	0.17	0.13	0.03	0.906
Month 3	3	0.25	0.19	0.07	0.810
Month 4	4	0.33	0.28	0.15	0.701
Month 5	5	0.42	0.38	0.29	0.570
Month 6	6	0.50	0.50	0.50	0.413
Month 7	7	0.58	0.62	0.71	0.250
Month 8	8	0.67	0.72	0.85	0.122
Month 9	9	0.75	0.81	0.93	0.049
Month 10	10	0.83	0.87	0.97	0.017
Month 11	11	0.92	0.91	0.99	0.005
Month 12	12	1.00	0.95	1.00	0.001
Project End			1.00	1.00	0.000

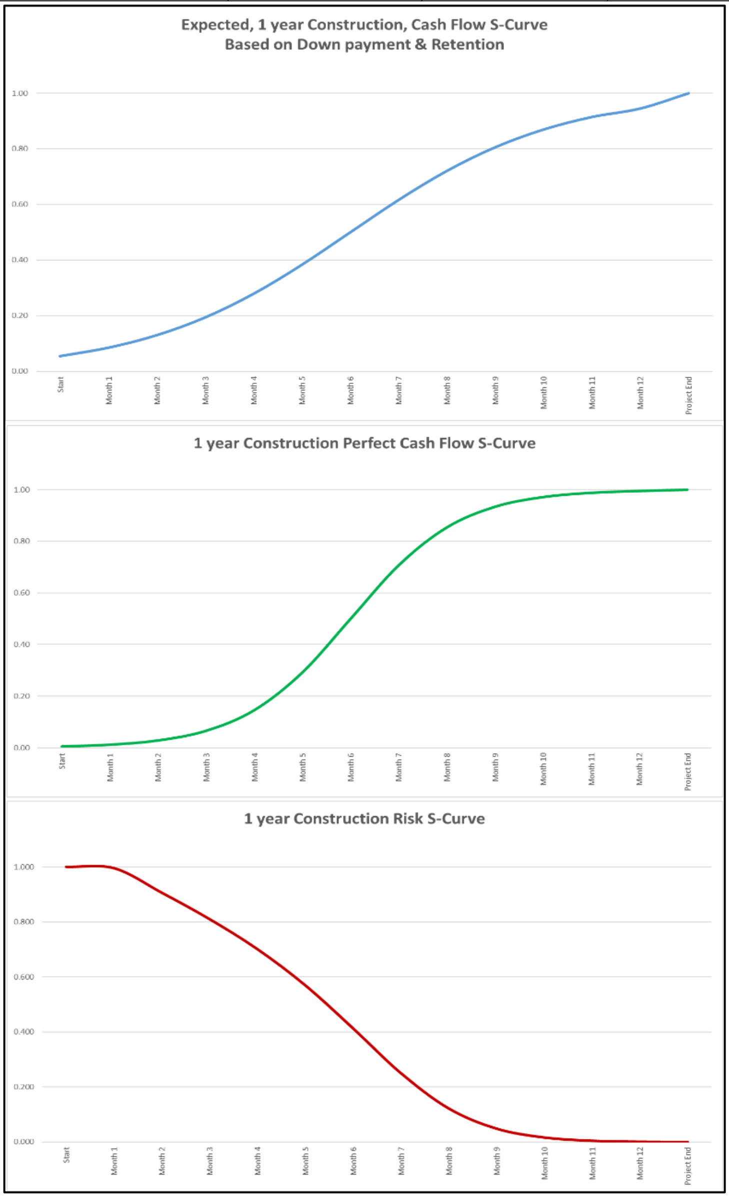

Figure 3. *Trending 1 year construction Cash flow and Risk S-Curves based on accepting retention bond.*

Table 3. *Identifying 1 year construction Cash flow and Risk S-Curves based on DNP/DLP without retention bond.*

Time Label	Month Interval (n)	Year Interval	Expected Cash Flow S-Curve Based on Down payment & Retention	Perfect Cash Flow S-Curve	Risk S-Curve
		"Month Interval (n)" * (1/ "# of time steps in a year (i.e., 12)")	1/(1+(EXP(-5.7*("Year Interval"-0.5))))	1/(1+(EXP(-10.6*("Year Interval"-0.5))))	((1 -"Year Interval (n-1)")/1)* (1-"Perfect Cash Flow S-Curve (n-1)")
Start	0	0.00	0.05	0.00	1.000
Month 1	1	0.08	0.09	0.01	0.995
Month 2	2	0.17	0.13	0.03	0.906
Month 3	3	0.25	0.19	0.07	0.810
Month 4	4	0.33	0.28	0.15	0.701
Month 5	5	0.42	0.38	0.29	0.570
Month 6	6	0.50	0.50	0.50	0.413
Month 7	7	0.58	0.62	0.71	0.250
Month 8	8	0.67	0.72	0.85	0.122
Month 9	9	0.75	0.81	0.93	0.049
Month 10	10	0.83	0.87	0.97	0.017
Month 11	11	0.92	0.91	0.99	0.005
Month 12	12	1.00	0.95	1.00	0.001
Month 13	13	1.08	0.95	1.00	0.000
Month 14	14	1.17	0.95	1.00	0.000
Month 15	15	1.25	0.95	1.00	0.000
Month 16	16	1.33	0.95	1.00	0.000
Month 17	17	1.42	0.95	1.00	0.000
Month 18	18	1.50	0.95	1.00	0.000
Month 19	19	1.58	0.95	1.00	0.000
Month 20	20	1.67	0.95	1.00	0.000
Month 21	21	1.75	0.95	1.00	0.000
Month 22	22	1.83	0.95	1.00	0.000
Month 23	23	1.92	0.95	1.00	0.000
Month 24	24	2.00	0.99	1.00	0.000
Month 25	25	2.08	0.99	1.00	0.000
Month 26	26	2.17	0.99	1.00	0.000
Month 27	27	2.25	0.99	1.00	0.000
Month 28	28	2.33	0.99	1.00	0.000
Month 29	29	2.42	0.99	1.00	0.000
Month 30	30	2.50	0.99	1.00	0.000
Month 31	31	2.58	0.99	1.00	0.000
Month 32	32	2.67	0.99	1.00	0.000
Month 33	33	2.75	0.99	1.00	0.000
Month 34	34	2.83	0.99	1.00	0.000
Month 35	35	2.92	0.99	1.00	0.000
Month 36	36	3.00	0.99	1.00	0.000
Month 37	37	3.08	0.99	1.00	0.000
Month 38	38	3.17	0.99	1.00	0.000
Month 39	39	3.25	0.99	1.00	0.000
Month 40	40	3.33	0.99	1.00	0.000
Month 41	41	3.42	0.99	1.00	0.000
Month 42	42	3.50	0.99	1.00	0.000
Month 43	43	3.58	0.99	1.00	0.000
Month 44	44	3.67	0.99	1.00	0.000
Month 45	45	3.75	0.99	1.00	0.000
Month 46	46	3.83	0.99	1.00	0.000
Month 47	47	3.92	0.99	1.00	0.000
Month 48	48	4.00	1.00	1.00	0.000
Project End			1.00	1.00	0.000

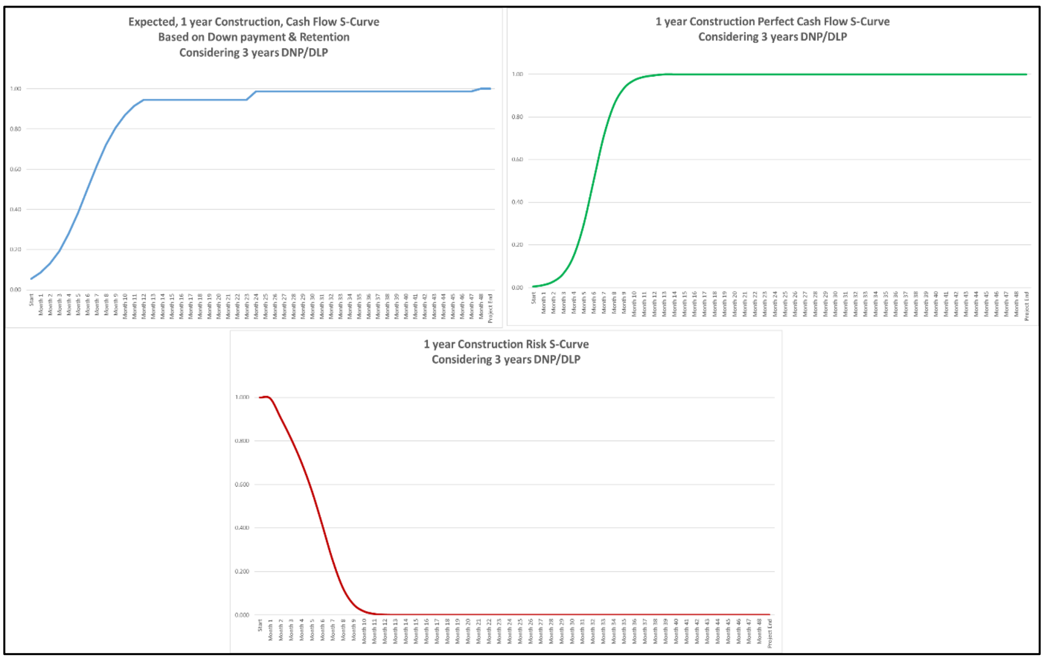

Figure 4. *Trending 1 year construction Cash flow and Risk S-Curves based on DNP/DLP without retention bond.*

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Table 4. *Identifying 2 years construction Cash flow and Risk S-Curves based on accepting retention bond.*

Time Label	Month Interval (n)	Year Interval	Expected Cash Flow S-Curve Based on Down payment & Retention	Perfect Cash Flow S-Curve	Risk S-Curve
		"Month Interval (n)" * (1/ "# of time steps in a year (i.e., 12)")	1/(1+(EXP(-3*("Year Interval"-1))))	1/(1+(EXP(-5.4*("Year Interval"-1))))	((2 -"Year Interval (n-1)")/2)* (1-"Perfect Cash Flow S-Curve (n-1)")
Start	0	0.00	0.05	0.00	1.000
Month 1	1	0.08	0.06	0.01	0.996
Month 2	2	0.17	0.08	0.01	0.952
Month 3	3	0.25	0.10	0.02	0.907
Month 4	4	0.33	0.12	0.03	0.860
Month 5	5	0.42	0.15	0.04	0.811
Month 6	6	0.50	0.18	0.06	0.759
Month 7	7	0.58	0.22	0.10	0.703
Month 8	8	0.67	0.27	0.14	0.641
Month 9	9	0.75	0.32	0.21	0.572
Month 10	10	0.83	0.38	0.29	0.497
Month 11	11	0.92	0.44	0.39	0.415
Month 12	12	1.00	0.50	0.50	0.331
Month 13	13	1.08	0.56	0.61	0.250
Month 14	14	1.17	0.62	0.71	0.179
Month 15	15	1.25	0.68	0.79	0.121
Month 16	16	1.33	0.73	0.86	0.077
Month 17	17	1.42	0.78	0.90	0.047
Month 18	18	1.50	0.82	0.94	0.028
Month 19	19	1.58	0.85	0.96	0.016
Month 20	20	1.67	0.88	0.97	0.009
Month 21	21	1.75	0.90	0.98	0.004
Month 22	22	1.83	0.92	0.99	0.002
Month 23	23	1.92	0.94	0.99	0.001
Month 24	24	2.00	0.95	1.00	0.000
Project End			1.00	1.00	0.000

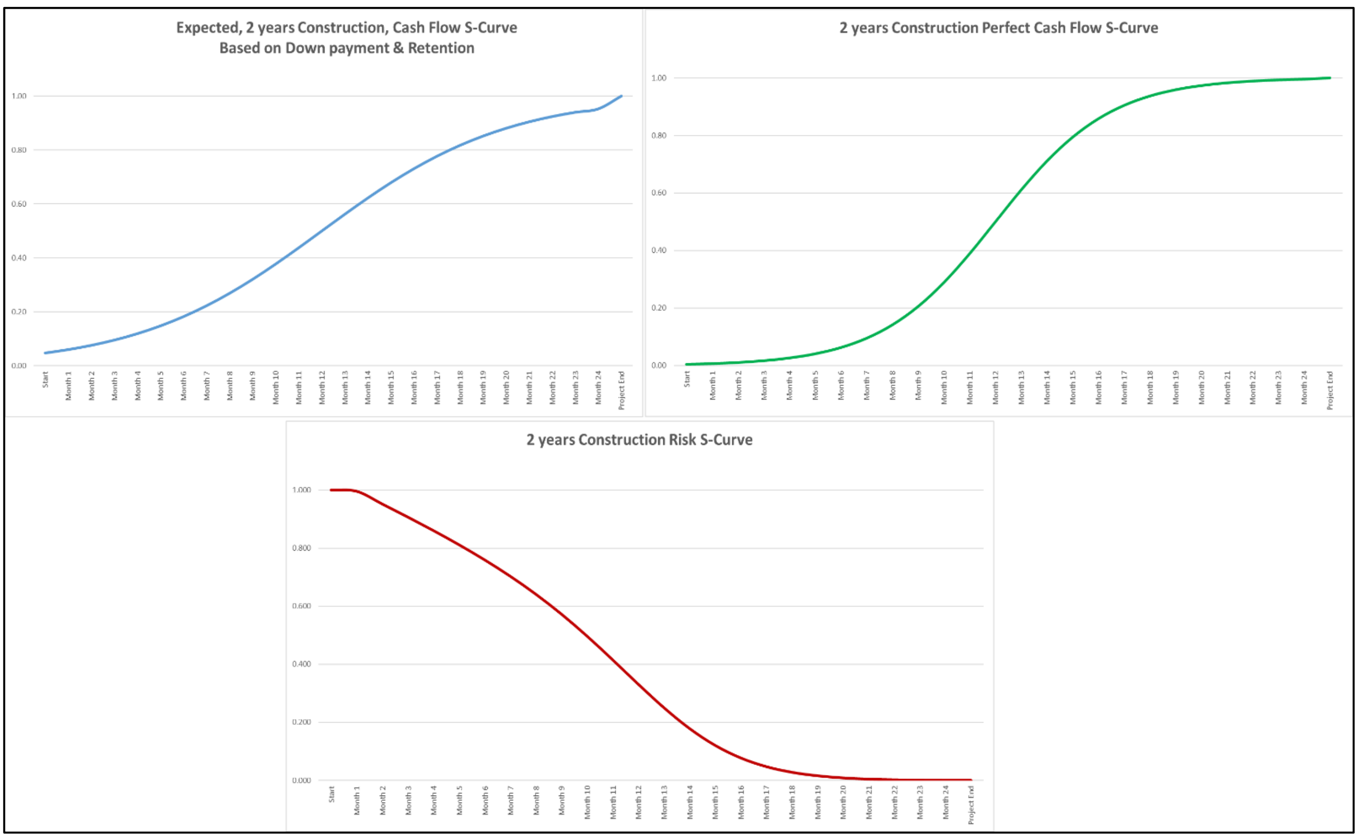

Figure 5. *Trending 2 years construction Cash flow and Risk S-Curves based on accepting retention bond.*

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Table 5. *Identifying 2 years construction Cash flow and Risk S-Curves based on DNP/DLP without retention bond.*

Time Label	Month Interval (n)	Year Interval	Expected Cash Flow S-Curve Based on Down payment & Retention	Perfect Cash Flow S-Curve	Risk S-Curve
		"Month Interval (n)" * (1/ "# of time steps in a year (i.e., 12)")	1/(1+(EXP(-3*("Year Interval"-1))))	1/(1+(EXP(-5.4*("Year Interval"-1))))	((2 -"Year Interval (n-1)")/2)* (1-"Perfect Cash Flow S-Curve (n-1)")
Start	0	0.00	0.05	0.00	1.000
Month 1	1	0.08	0.06	0.01	0.996
Month 2	2	0.17	0.08	0.01	0.952
Month 3	3	0.25	0.10	0.02	0.907
Month 4	4	0.33	0.12	0.03	0.860
Month 5	5	0.42	0.15	0.04	0.811
Month 6	6	0.50	0.18	0.06	0.759
Month 7	7	0.58	0.22	0.10	0.703
Month 8	8	0.67	0.27	0.14	0.641
Month 9	9	0.75	0.32	0.21	0.572
Month 10	10	0.83	0.38	0.29	0.497
Month 11	11	0.92	0.44	0.39	0.415
Month 12	12	1.00	0.50	0.50	0.331
Month 13	13	1.08	0.56	0.61	0.250
Month 14	14	1.17	0.62	0.71	0.179
Month 15	15	1.25	0.68	0.79	0.121
Month 16	16	1.33	0.73	0.86	0.077
Month 17	17	1.42	0.78	0.90	0.047
Month 18	18	1.50	0.82	0.94	0.028
Month 19	19	1.58	0.85	0.96	0.016
Month 20	20	1.67	0.88	0.97	0.009
Month 21	21	1.75	0.90	0.98	0.004
Month 22	22	1.83	0.92	0.99	0.002
Month 23	23	1.92	0.94	0.99	0.001
Month 24	24	2.00	0.95	1.00	0.000
Month 25	25	2.08	0.95	1	0.000
Month 26	26	2.17	0.95	1	0.000
Month 27	27	2.25	0.95	1	0.000
Month 28	28	2.33	0.95	1	0.000
Month 29	29	2.42	0.95	1	0.000
Month 30	30	2.50	0.95	1	0.000
Month 31	31	2.58	0.95	1	0.000
Month 32	32	2.67	0.95	1	0.000
Month 33	33	2.75	0.95	1	0.000
Month 34	34	2.83	0.95	1	0.000
Month 35	35	2.92	0.95	1	0.000
Month 36	36	3.00	0.99	1	0.000
Month 37	37	3.08	0.99	1	0.000
Month 38	38	3.17	0.99	1	0.000
Month 39	39	3.25	0.99	1	0.000
Month 40	40	3.33	0.99	1	0.000
Month 41	41	3.42	0.99	1	0.000
Month 42	42	3.50	0.99	1	0.000
Month 43	43	3.58	0.99	1	0.000
Month 44	44	3.67	0.99	1	0.000
Month 45	45	3.75	0.99	1	0.000
Month 46	46	3.83	0.99	1	0.000
Month 47	47	3.92	0.99	1	0.000
Month 48	48	4.00	0.99	1	0.000
Month 49	49	4.08	0.99	1	0.000
Month 50	50	4.17	0.99	1	0.000
Month 51	51	4.25	0.99	1	0.000
Month 52	52	4.33	0.99	1	0.000
Month 53	53	4.41	0.99	1	0.000
Month 54	54	4.50	0.99	1	0.000
Month 55	55	4.58	0.99	1	0.000
Month 56	56	4.66	0.99	1	0.000
Month 57	57	4.75	0.99	1	0.000
Month 58	58	4.83	0.99	1	0.000
Month 59	59	4.91	0.99	1	0.000
Month 60	60	5.00	1.00	1	0.000
Project End			1.00	1	0.000

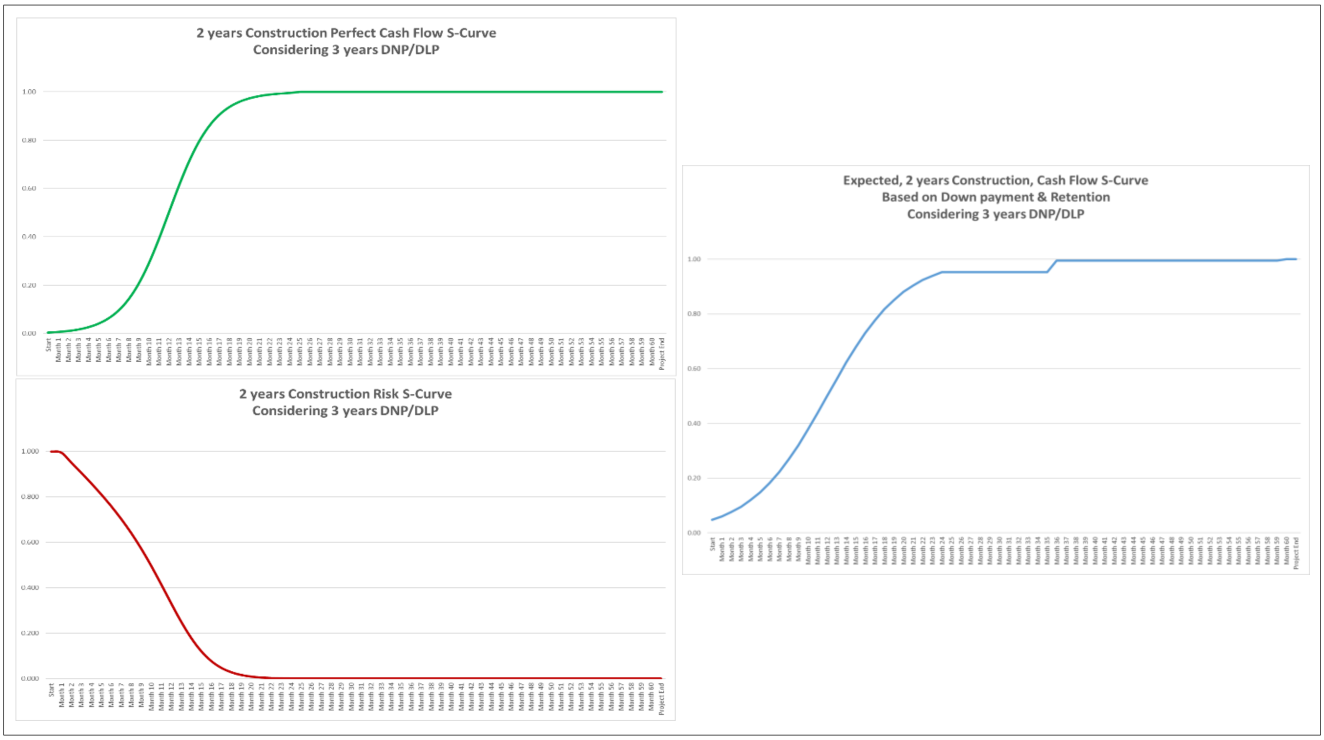

Figure 6. *Trending 2 years construction Cash flow and Risk S-Curves based on DNP/DLP without retention bond.*

Table 6. *Identifying 3 years construction Cash flow and Risk S-Curve based on accepting retention bond.*

Time Label	Month Interval (n)	Year Interval	Expected Cash Flow S-Curve Based on Down payment & Retention	Perfect Cash Flow S-Curve	Risk S-Curve
		"Month Interval (n)" * (1/ "# of time steps in a year (i.e., 12)")	1/(1+(EXP(-2*("Year Interval"-1.5))))	1/(1+(EXP(-3.68*("Year Interval"-1.5))))	((3 -"Year Interval (n-1)")/3)* (1-"Perfect Cash Flow S-Curve (n-1)")
Start	0	0.00	0.05	0.00	1.000
Month 1	1	0.08	0.06	0.01	0.996
Month 2	2	0.17	0.06	0.01	0.967
Month 3	3	0.25	0.08	0.01	0.938
Month 4	4	0.33	0.09	0.01	0.908
Month 5	5	0.42	0.10	0.02	0.877
Month 6	6	0.50	0.12	0.02	0.845
Month 7	7	0.58	0.14	0.03	0.813
Month 8	8	0.67	0.16	0.04	0.779
Month 9	9	0.75	0.18	0.06	0.743
Month 10	10	0.83	0.21	0.08	0.705
Month 11	11	0.92	0.24	0.10	0.665
Month 12	12	1.00	0.27	0.14	0.622
Month 13	13	1.08	0.30	0.18	0.576
Month 14	14	1.17	0.34	0.23	0.526
Month 15	15	1.25	0.38	0.28	0.473
Month 16	16	1.33	0.42	0.35	0.417
Month 17	17	1.42	0.46	0.42	0.361
Month 18	18	1.50	0.50	0.50	0.304
Month 19	19	1.58	0.54	0.58	0.250
Month 20	20	1.67	0.58	0.65	0.201
Month 21	21	1.75	0.62	0.71	0.156
Month 22	22	1.83	0.66	0.77	0.119
Month 23	23	1.92	0.70	0.82	0.088
Month 24	24	2.00	0.73	0.86	0.064
Month 25	25	2.08	0.76	0.90	0.046
Month 26	26	2.17	0.79	0.92	0.032
Month 27	27	2.25	0.82	0.94	0.022
Month 28	28	2.33	0.84	0.96	0.015
Month 29	29	2.42	0.86	0.97	0.010
Month 30	30	2.50	0.88	0.98	0.006
Month 31	31	2.58	0.90	0.98	0.004
Month 32	32	2.67	0.91	0.99	0.003
Month 33	33	2.75	0.92	0.99	0.002
Month 34	34	2.83	0.93	0.99	0.001
Month 35	35	2.92	0.94	0.99	0.000
Month 36	36	3.00	0.95	1.00	0.000
Project End			1.00	1.00	0.000

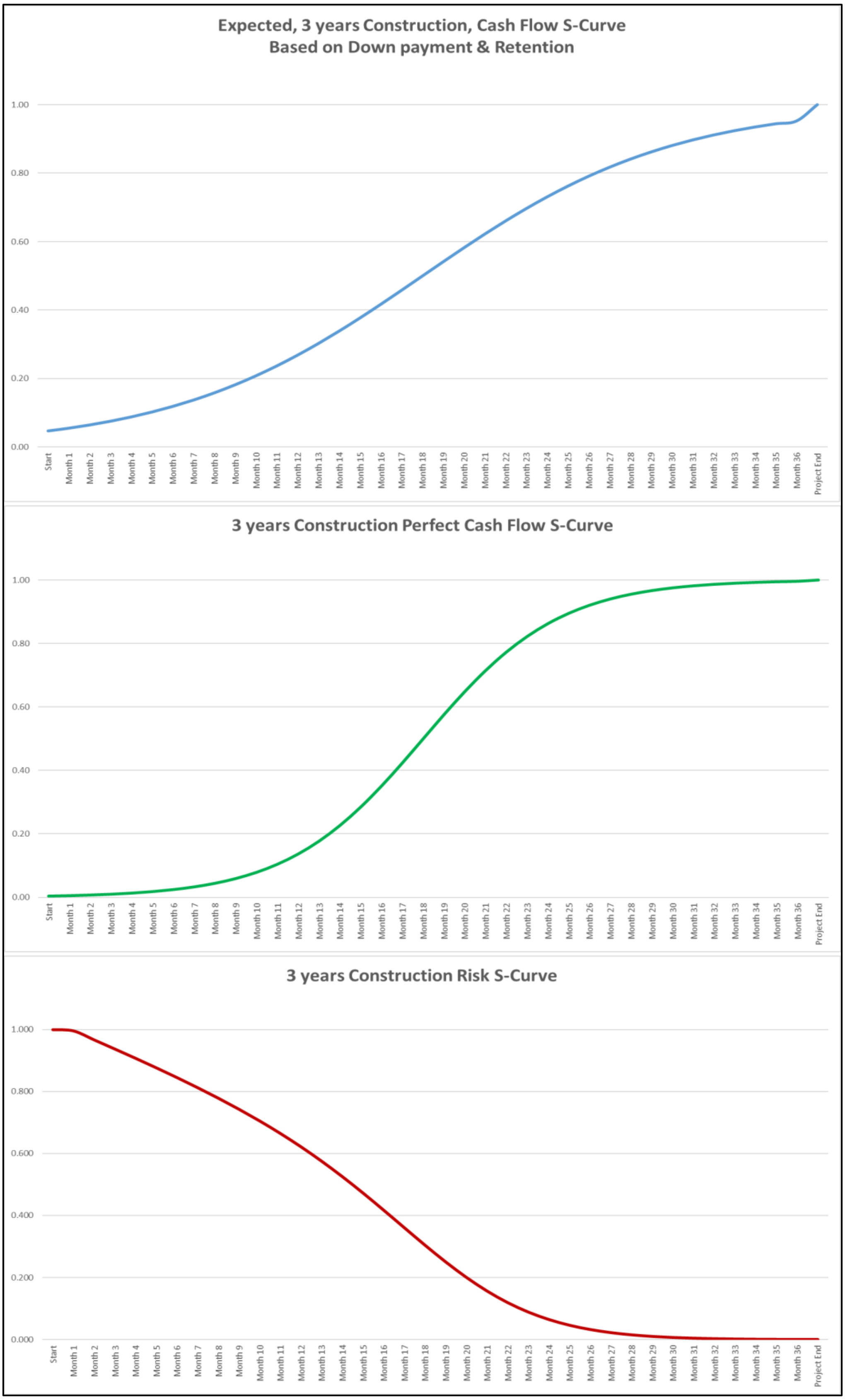

Figure 7. *Trending 3 years construction Cash flow and Risk S-Curves based on accepting retention bond.*

Table 7. *Identifying 3 years construction Cash flow and Risk S-Curves based on DNP/DLP without retention bond.*

Time Label	Month Interval (n)	Year Interval	Expected Cash Flow S-Curve Based on Down payment & Retention	Perfect Cash Flow S-Curve	Risk S-Curve
		"Month Interval (n)" * (1/ "# of time steps in a year (i.e., 12)")	1/(1+(EXP(-2*("Year Interval"-1.5))))	1/(1+(EXP(-3.68*("Year Interval"-1.5))))	((3 -"Year Interval (n-1)")/3)* (1-"Perfect Cash Flow S-Curve (n-1)")
Start	0	0.00	0.05	0.00	1.000
Month 1	1	0.08	0.06	0.01	0.996
Month 2	2	0.17	0.06	0.01	0.967
Month 3	3	0.25	0.08	0.01	0.938
Month 4	4	0.33	0.09	0.01	0.908
Month 5	5	0.42	0.10	0.02	0.877
Month 6	6	0.50	0.12	0.02	0.845
Month 7	7	0.58	0.14	0.03	0.813
Month 8	8	0.67	0.16	0.04	0.779
Month 9	9	0.75	0.18	0.06	0.743
Month 10	10	0.83	0.21	0.08	0.705
Month 11	11	0.92	0.24	0.10	0.665
Month 12	12	1.00	0.27	0.14	0.622
Month 13	13	1.08	0.30	0.18	0.576
Month 14	14	1.17	0.34	0.23	0.526
Month 15	15	1.25	0.38	0.28	0.473
Month 16	16	1.33	0.42	0.35	0.417
Month 17	17	1.42	0.46	0.42	0.361
Month 18	18	1.50	0.50	0.50	0.304
Month 19	19	1.58	0.54	0.58	0.250
Month 20	20	1.67	0.58	0.65	0.201
Month 21	21	1.75	0.62	0.71	0.156
Month 22	22	1.83	0.66	0.77	0.119
Month 23	23	1.92	0.70	0.82	0.088
Month 24	24	2.00	0.73	0.86	0.064
Month 25	25	2.08	0.76	0.90	0.046
Month 26	26	2.17	0.79	0.92	0.032
Month 27	27	2.25	0.82	0.94	0.022
Month 28	28	2.33	0.84	0.96	0.015
Month 29	29	2.42	0.86	0.97	0.010
Month 30	30	2.50	0.88	0.98	0.006
Month 31	31	2.58	0.90	0.98	0.004
Month 32	32	2.67	0.91	0.99	0.003
Month 33	33	2.75	0.92	0.99	0.002
Month 34	34	2.83	0.93	0.99	0.001
Month 35	35	2.92	0.94	0.99	0.000
Month 36	36	3.00	0.95	1.00	0.000
Month 37	37	3.08	0.95	1	0.000
Month 38	38	3.17	0.95	1	0.000
Month 39	39	3.25	0.95	1	0.000
Month 40	40	3.33	0.95	1	0.000
Month 41	41	3.42	0.95	1	0.000
Month 42	42	3.50	0.95	1	0.000
Month 43	43	3.58	0.95	1	0.000
Month 44	44	3.67	0.95	1	0.000
Month 45	45	3.75	0.95	1	0.000
Month 46	46	3.83	0.95	1	0.000
Month 47	47	3.92	0.95	1	0.000
Month 48	48	4.00	0.99	1	0.000
Month 49	49	4.08	0.99	1	0.000
Month 50	50	4.17	0.99	1	0.000
Month 51	51	4.25	0.99	1	0.000
Month 52	52	4.33	0.99	1	0.000
Month 53	53	4.41	0.99	1	0.000
Month 54	54	4.50	0.99	1	0.000
Month 55	55	4.58	0.99	1	0.000
Month 56	56	4.66	0.99	1	0.000
Month 57	57	4.75	0.99	1	0.000
Month 58	58	4.83	0.99	1	0.000
Month 59	59	4.91	0.99	1	0.000
Month 60	60	5.00	0.99	1	0.000
Month 61	61	5.08	0.99	1	0.000
Month 62	62	5.16	0.99	1	0.000
Month 63	63	5.25	0.99	1	0.000
Month 64	64	5.33	0.99	1	0.000
Month 65	65	5.41	0.99	1	0.000
Month 66	66	5.50	0.99	1	0.000
Month 67	67	5.58	0.99	1	0.000
Month 68	68	5.66	0.99	1	0.000
Month 69	69	5.75	0.99	1	0.000
Month 70	70	5.83	0.99	1	0.000
Month 71	71	5.91	0.99	1	0.000
Month 72	72	6.00	1.00	1	0.000
Project End			1.00	1	0.000

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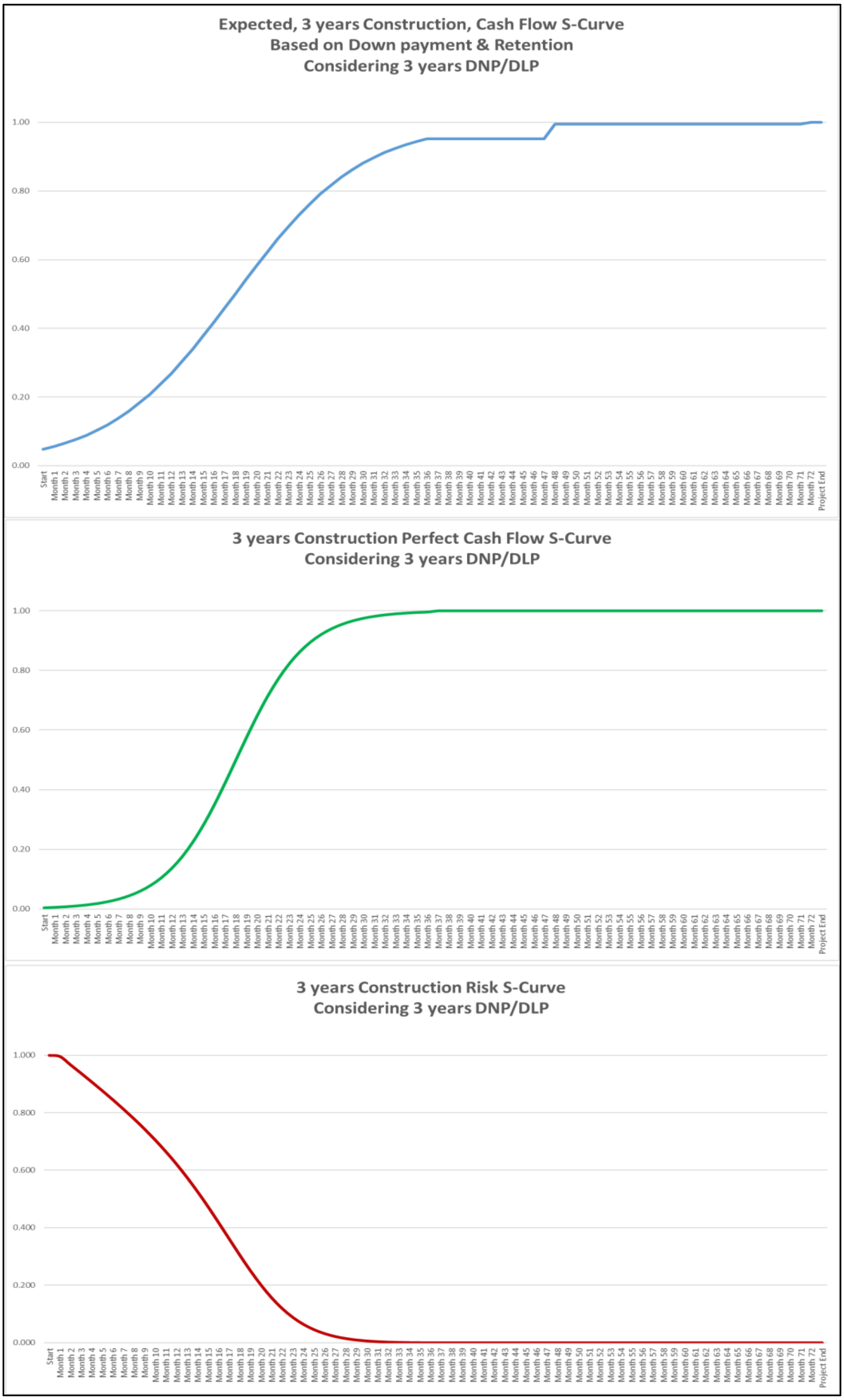

Figure 8. *Trending 3 years construction Cash flow and Risk S-Curves based on DNP/DLP without retention bond.*

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Table 8. *Identifying 4 years construction Cash flow and Risk S-Curve based on accepting retention bond.*

Time Label	Month Interval (n)	Year Interval	Expected Cash Flow S-Curve Based on Down payment & Retention	Perfect Cash Flow S-Curve	Risk S-Curve
		"Month Interval (n)" * (1/ "# of time steps in a year (i.e., 12)")	1/(1+(EXP(-1.46*("Year Interval"-2))))	1/(1+(EXP(-2.65*("Year Interval"-2))))	((4 -"Year Interval (n-1)")/4)* (1-"Perfect Cash Flow S-Curve (n-1)")
Start	0	0.00	0.05	0.00	1.000
Month 1	1	0.08	0.06	0.01	0.995
Month 2	2	0.17	0.06	0.01	0.973
Month 3	3	0.25	0.07	0.01	0.951
Month 4	4	0.33	0.08	0.01	0.929
Month 5	5	0.42	0.09	0.01	0.906
Month 6	6	0.50	0.10	0.02	0.883
Month 7	7	0.58	0.11	0.02	0.859
Month 8	8	0.67	0.12	0.03	0.835
Month 9	9	0.75	0.14	0.04	0.810
Month 10	10	0.83	0.15	0.04	0.784
Month 11	11	0.92	0.17	0.05	0.757
Month 12	12	1.00	0.19	0.07	0.730
Month 13	13	1.08	0.21	0.08	0.701
Month 14	14	1.17	0.23	0.10	0.670
Month 15	15	1.25	0.25	0.12	0.638
Month 16	16	1.33	0.27	0.15	0.605
Month 17	17	1.42	0.30	0.18	0.570
Month 18	18	1.50	0.33	0.21	0.533
Month 19	19	1.58	0.35	0.25	0.494
Month 20	20	1.67	0.38	0.29	0.454
Month 21	21	1.75	0.41	0.34	0.413
Month 22	22	1.83	0.44	0.39	0.371
Month 23	23	1.92	0.47	0.44	0.330
Month 24	24	2.00	0.50	0.50	0.289
Month 25	25	2.08	0.53	0.55	0.250
Month 26	26	2.17	0.56	0.61	0.214
Month 27	27	2.25	0.59	0.66	0.180
Month 28	28	2.33	0.62	0.71	0.149
Month 29	29	2.42	0.65	0.75	0.122
Month 30	30	2.50	0.67	0.79	0.099
Month 31	31	2.58	0.70	0.82	0.079
Month 32	32	2.67	0.73	0.85	0.062
Month 33	33	2.75	0.75	0.88	0.049
Month 34	34	2.83	0.77	0.90	0.038
Month 35	35	2.92	0.79	0.92	0.029
Month 36	36	3.00	0.81	0.93	0.022
Month 37	37	3.08	0.83	0.95	0.017
Month 38	38	3.17	0.85	0.96	0.012
Month 39	39	3.25	0.86	0.96	0.009
Month 40	40	3.33	0.87	0.97	0.007
Month 41	41	3.42	0.89	0.98	0.005
Month 42	42	3.50	0.90	0.98	0.003
Month 43	43	3.58	0.91	0.99	0.002
Month 44	44	3.67	0.92	0.99	0.002
Month 45	45	3.75	0.93	0.99	0.001
Month 46	46	3.83	0.94	0.99	0.001
Month 47	47	3.92	0.94	0.99	0.000
Month 48	48	4.00	0.95	1.00	0.000
Project End			1.00	1.00	0.000

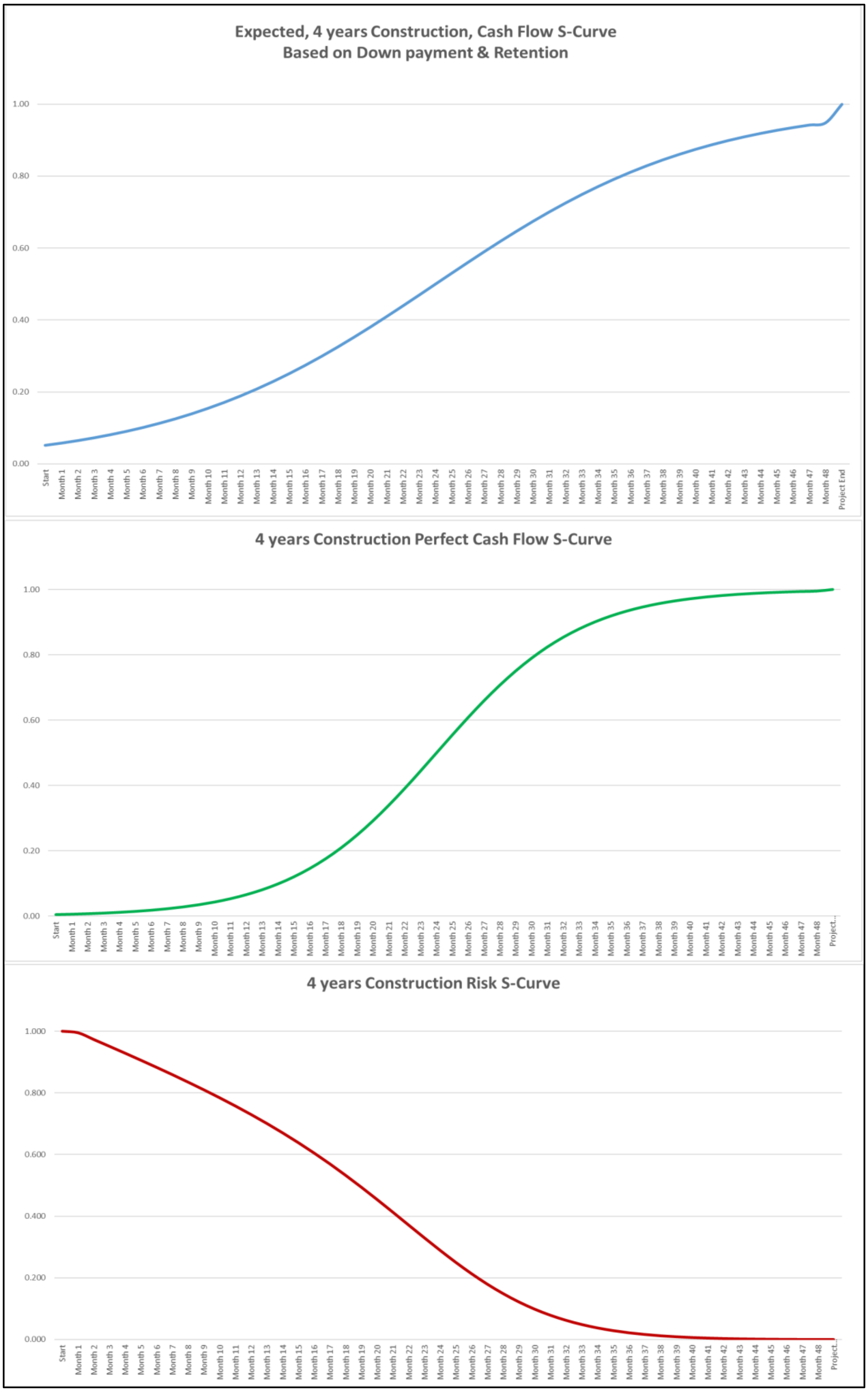

Figure 9. *Trending 4 years construction Cash flow and Risk S-Curves based on accepting retention bond.*

Table 9. *Identifying 4 years construction Cash flow and Risk S-Curves based on DNP/DLP without retention bond.*

Time Label	Month Interval (n)	Year Interval	Expected Cash Flow S-Curve Based on Down payment & Retention	Perfect Cash Flow S-Curve	Risk S-Curve
		"Month Interval (n)" * (1/ "# of time steps in a year (i.e., 12)")	1/(1+(EXP(-1.46*("Year Interval"-2))))	1/(1+(EXP(-2.65*("Year Interval"-2))))	((4 -"Year Interval (n-1)")/4)* (1-"Perfect Cash Flow S-Curve (n-1)")
Start	0	0.00	0.05	0.00	1.000
Month 1	1	0.08	0.06	0.01	0.995
Month 2	2	0.17	0.06	0.01	0.973
Month 3	3	0.25	0.07	0.01	0.951
Month 4	4	0.33	0.08	0.01	0.929
Month 5	5	0.42	0.09	0.01	0.906
Month 6	6	0.50	0.10	0.02	0.883
Month 7	7	0.58	0.11	0.02	0.859
Month 8	8	0.67	0.12	0.03	0.835
Month 9	9	0.75	0.14	0.04	0.810
Month 10	10	0.83	0.15	0.04	0.784
Month 11	11	0.92	0.17	0.05	0.757
Month 12	12	1.00	0.19	0.07	0.730
Month 13	13	1.08	0.21	0.08	0.701
Month 14	14	1.17	0.23	0.10	0.670
Month 15	15	1.25	0.25	0.12	0.638
Month 16	16	1.33	0.27	0.15	0.605
Month 17	17	1.42	0.30	0.18	0.570
Month 18	18	1.50	0.33	0.21	0.533
Month 19	19	1.58	0.35	0.25	0.494
Month 20	20	1.67	0.38	0.29	0.454
Month 21	21	1.75	0.41	0.34	0.413
Month 22	22	1.83	0.44	0.39	0.371
Month 23	23	1.92	0.47	0.44	0.330
Month 24	24	2.00	0.50	0.50	0.289
Month 25	25	2.08	0.53	0.55	0.250
Month 26	26	2.17	0.56	0.61	0.214
Month 27	27	2.25	0.59	0.66	0.180
Month 28	28	2.33	0.62	0.71	0.149
Month 29	29	2.42	0.65	0.75	0.122
Month 30	30	2.50	0.67	0.79	0.099
Month 31	31	2.58	0.70	0.82	0.079
Month 32	32	2.67	0.73	0.85	0.062
Month 33	33	2.75	0.75	0.88	0.049
Month 34	34	2.83	0.77	0.90	0.038
Month 35	35	2.92	0.79	0.92	0.029
Month 36	36	3.00	0.81	0.93	0.022
Month 37	37	3.08	0.83	0.95	0.017
Month 38	38	3.17	0.85	0.96	0.012
Month 39	39	3.25	0.86	0.96	0.009
Month 40	40	3.33	0.87	0.97	0.007
Month 41	41	3.42	0.89	0.98	0.005
Month 42	42	3.50	0.90	0.98	0.003
Month 43	43	3.58	0.91	0.99	0.002
Month 44	44	3.67	0.92	0.99	0.002
Month 45	45	3.75	0.93	0.99	0.001
Month 46	46	3.83	0.94	0.99	0.001
Month 47	47	3.92	0.94	0.99	0.000
Month 48	48	4.00	0.95	1.00	0.000
Month 49	49	4.08	0.95	1	0.000
Month 50	50	4.17	0.95	1	0.000
Month 51	51	4.25	0.95	1	0.000
Month 52	52	4.33	0.95	1	0.000
Month 53	53	4.41	0.95	1	0.000
Month 54	54	4.50	0.95	1	0.000
Month 55	55	4.58	0.95	1	0.000
Month 56	56	4.66	0.95	1	0.000
Month 57	57	4.75	0.95	1	0.000
Month 58	58	4.83	0.95	1	0.000
Month 59	59	4.91	0.95	1	0.000
Month 60	60	5.00	0.99	1	0.000
Month 61	61	5.08	0.99	1	0.000
Month 62	62	5.16	0.99	1	0.000
Month 63	63	5.25	0.99	1	0.000
Month 64	64	5.33	0.99	1	0.000
Month 65	65	5.41	0.99	1	0.000
Month 66	66	5.50	0.99	1	0.000
Month 67	67	5.58	0.99	1	0.000
Month 68	68	5.66	0.99	1	0.000
Month 69	69	5.75	0.99	1	0.000
Month 70	70	5.83	0.99	1	0.000
Month 71	71	5.91	0.99	1	0.000
Month 72	72	6.00	0.99	1	0.000
Month 73	73	6.08	0.99	1	0.000
Month 74	74	6.16	0.99	1	0.000
Month 75	75	6.25	0.99	1	0.000
Month 76	76	6.33	0.99	1	0.000
Month 77	77	6.41	0.99	1	0.000
Month 78	78	6.50	0.99	1	0.000
Month 79	79	6.58	0.99	1	0.000
Month 80	80	6.66	0.99	1	0.000
Month 81	81	6.75	0.99	1	0.000
Month 82	82	6.83	0.99	1	0.000
Month 83	83	6.91	0.99	1	0.000
Month 84	84	7.00	1	1	0.000
Project End			1	1	0.000

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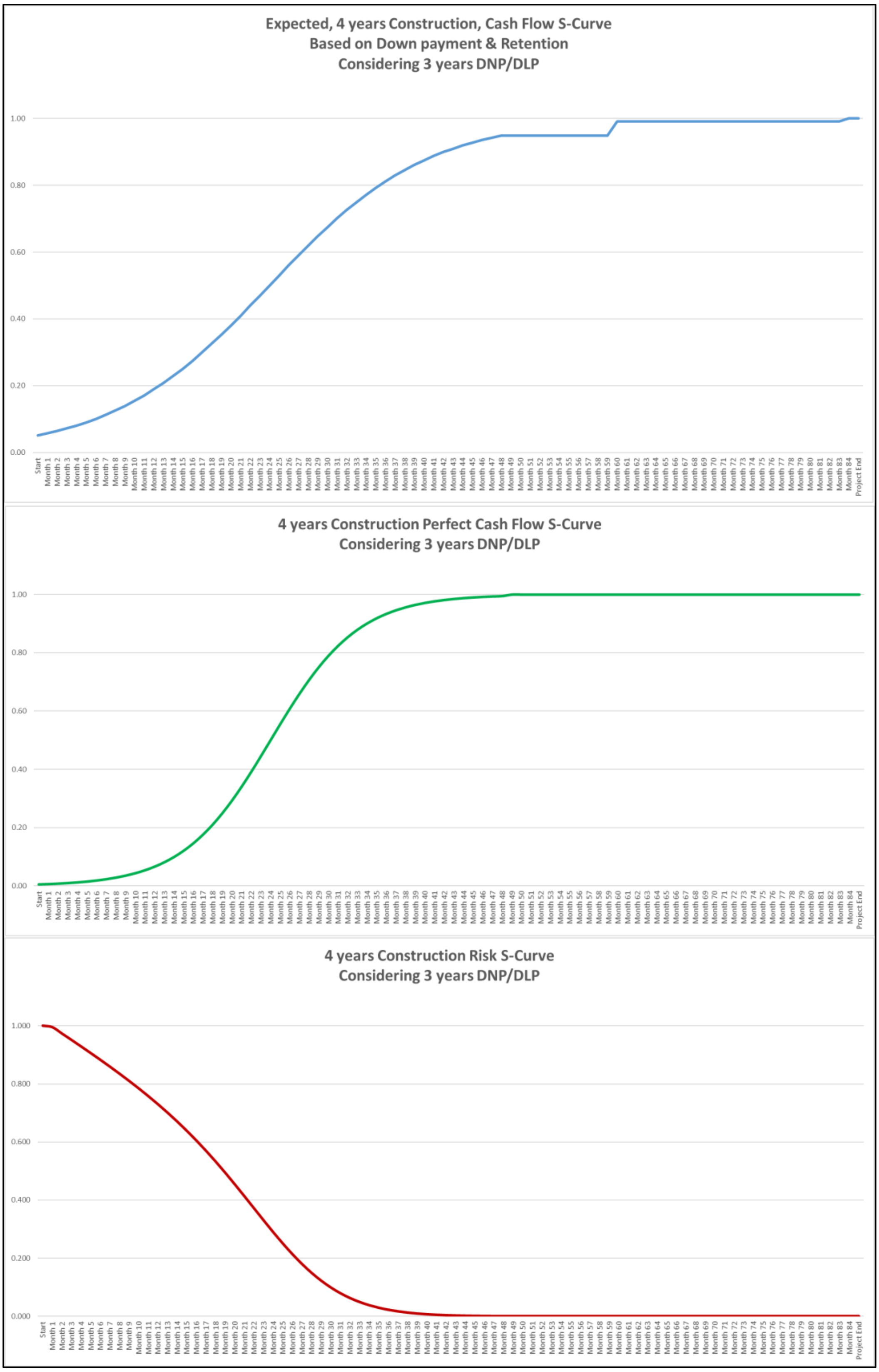

Figure 10. *Trending 4 years construction Cash flow and Risk S-Curves based on DNP/DLP without retention bond.*

Table 10. *Identifying 5 years construction Cash flow and Risk S-Curves based on accepting retention bond.*

Time Label	Month Interval (n)	Year Interval	Expected Cash Flow S-Curve Based on Down payment & Retention	Perfect Cash Flow S-Curve	Risk S-Curve
		"Month Interval (n)" * (1/ "# of time steps in a year (i.e., 12)")	1/(1+(EXP(-1.2*("Year Interval"-2.5))))	1/(1+(EXP(-2.15*("Year Interval"-2.5))))	((5 -"Year Interval (n-1)")/5)* (1-"Perfect Cash Flow S-Curve (n-1)")
Start	0	0.00	0.05	0.00	1.000
Month 1	1	0.08	0.05	0.01	0.995
Month 2	2	0.17	0.06	0.01	0.978
Month 3	3	0.25	0.06	0.01	0.960
Month 4	4	0.33	0.07	0.01	0.943
Month 5	5	0.42	0.08	0.01	0.925
Month 6	6	0.50	0.08	0.01	0.906
Month 7	7	0.58	0.09	0.02	0.888
Month 8	8	0.67	0.10	0.02	0.869
Month 9	9	0.75	0.11	0.02	0.850
Month 10	10	0.83	0.12	0.03	0.831
Month 11	11	0.92	0.13	0.03	0.811
Month 12	12	1.00	0.14	0.04	0.790
Month 13	13	1.08	0.15	0.05	0.770
Month 14	14	1.17	0.17	0.05	0.748
Month 15	15	1.25	0.18	0.06	0.726
Month 16	16	1.33	0.20	0.08	0.702
Month 17	17	1.42	0.21	0.09	0.678
Month 18	18	1.50	0.23	0.10	0.653
Month 19	19	1.58	0.25	0.12	0.627
Month 20	20	1.67	0.27	0.14	0.600
Month 21	21	1.75	0.29	0.17	0.572
Month 22	22	1.83	0.31	0.19	0.542
Month 23	23	1.92	0.33	0.22	0.512
Month 24	24	2.00	0.35	0.25	0.480
Month 25	25	2.08	0.38	0.29	0.448
Month 26	26	2.17	0.40	0.33	0.415
Month 27	27	2.25	0.43	0.37	0.381
Month 28	28	2.33	0.45	0.41	0.348
Month 29	29	2.42	0.47	0.45	0.314
Month 30	30	2.50	0.50	0.50	0.282
Month 31	31	2.58	0.52	0.54	0.250
Month 32	32	2.67	0.55	0.59	0.220
Month 33	33	2.75	0.57	0.63	0.192
Month 34	34	2.83	0.60	0.67	0.166
Month 35	35	2.92	0.62	0.71	0.142
Month 36	36	3.00	0.65	0.75	0.121
Month 37	37	3.08	0.67	0.78	0.102
Month 38	38	3.17	0.69	0.81	0.085
Month 39	39	3.25	0.71	0.83	0.071
Month 40	40	3.33	0.73	0.86	0.058
Month 41	41	3.42	0.75	0.88	0.048
Month 42	42	3.50	0.77	0.90	0.039
Month 43	43	3.58	0.79	0.91	0.031
Month 44	44	3.67	0.80	0.92	0.025
Month 45	45	3.75	0.82	0.94	0.020
Month 46	46	3.83	0.83	0.95	0.016
Month 47	47	3.92	0.85	0.95	0.013
Month 48	48	4.00	0.86	0.96	0.010
Month 49	49	4.08	0.87	0.97	0.008
Month 50	50	4.17	0.88	0.97	0.006
Month 51	51	4.25	0.89	0.98	0.005
Month 52	52	4.33	0.90	0.98	0.003
Month 53	53	4.41	0.91	0.98	0.003
Month 54	54	4.50	0.92	0.99	0.002
Month 55	55	4.58	0.92	0.99	0.001
Month 56	56	4.66	0.93	0.99	0.001
Month 57	57	4.75	0.94	0.99	0.001
Month 58	58	4.83	0.94	0.99	0.000
Month 59	59	4.91	0.95	0.99	0.000
Month 60	60	5.00	0.95	1.00	0.000
Project End			1.00	1.00	0.000

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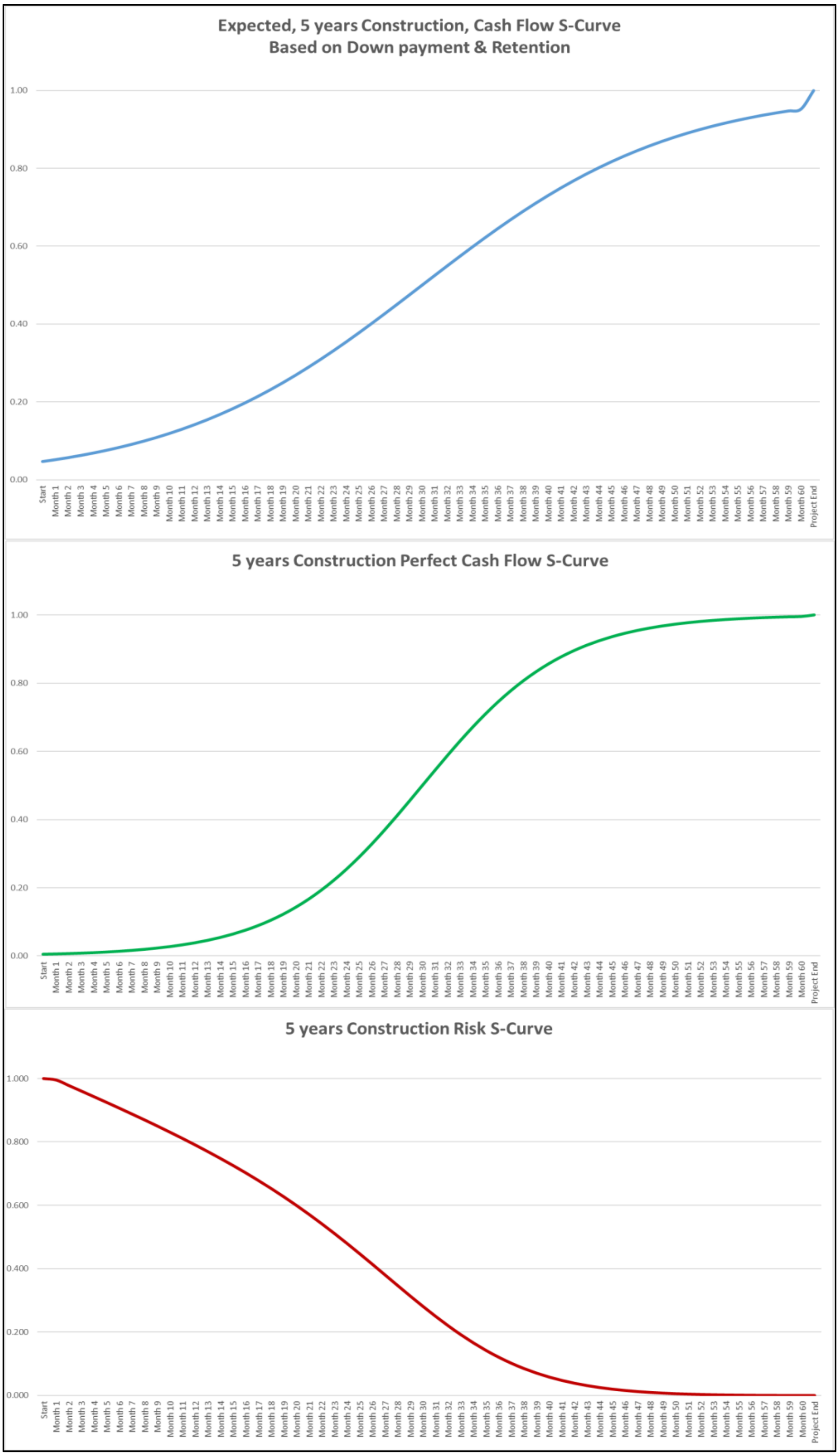

Figure 11. *Trending 5 years construction Cash flow and Risk S-Curves based on accepting retention bond.*

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Table 11. *Identifying 5 years construction Cash flow and Risk S-Curves based on DNP/DLP without retention bond.*

Time Label	Month Interval (n)	Year Interval	Expected Cash Flow S-Curve Based on Down payment & Retention	Perfect Cash Flow S-Curve	Risk S-Curve
		"Month Interval (n)" * (1/ "# of time steps in a year (i.e., 12)")	1/(1+(EXP(-1.2*("Year Interval"-2.5))))	1/(1+(EXP(-2.15*("Year Interval"-2.5))))	((5 -"Year Interval (n-1)")/5)* (1-"Perfect Cash Flow S-Curve (n-1)")
Start	0	0.00	0.05	0.00	1.000
Month 1	1	0.08	0.05	0.01	0.995
Month 2	2	0.17	0.06	0.01	0.978
Month 3	3	0.25	0.06	0.01	0.960
Month 4	4	0.33	0.07	0.01	0.943
Month 5	5	0.42	0.08	0.01	0.925
Month 6	6	0.50	0.08	0.01	0.906
Month 7	7	0.58	0.09	0.02	0.888
Month 8	8	0.67	0.10	0.02	0.869
Month 9	9	0.75	0.11	0.02	0.850
Month 10	10	0.83	0.12	0.03	0.831
Month 11	11	0.92	0.13	0.03	0.811
Month 12	12	1.00	0.14	0.04	0.790
Month 13	13	1.08	0.15	0.05	0.770
Month 14	14	1.17	0.17	0.05	0.748
Month 15	15	1.25	0.18	0.06	0.726
Month 16	16	1.33	0.20	0.08	0.702
Month 17	17	1.42	0.21	0.09	0.678
Month 18	18	1.50	0.23	0.10	0.653
Month 19	19	1.58	0.25	0.12	0.627
Month 20	20	1.67	0.27	0.14	0.600
Month 21	21	1.75	0.29	0.17	0.572
Month 22	22	1.83	0.31	0.19	0.542
Month 23	23	1.92	0.33	0.22	0.512
Month 24	24	2.00	0.35	0.25	0.480
Month 25	25	2.08	0.38	0.29	0.448
Month 26	26	2.17	0.40	0.33	0.415
Month 27	27	2.25	0.43	0.37	0.381
Month 28	28	2.33	0.45	0.41	0.348
Month 29	29	2.42	0.47	0.45	0.314
Month 30	30	2.50	0.50	0.50	0.282
Month 31	31	2.58	0.52	0.54	0.250
Month 32	32	2.67	0.55	0.59	0.220
Month 33	33	2.75	0.57	0.63	0.192
Month 34	34	2.83	0.60	0.67	0.166
Month 35	35	2.92	0.62	0.71	0.142
Month 36	36	3.00	0.65	0.75	0.121
Month 37	37	3.08	0.67	0.78	0.102
Month 38	38	3.17	0.69	0.81	0.085
Month 39	39	3.25	0.71	0.83	0.071
Month 40	40	3.33	0.73	0.86	0.058
Month 41	41	3.42	0.75	0.88	0.048
Month 42	42	3.50	0.77	0.90	0.039
Month 43	43	3.58	0.79	0.91	0.031
Month 44	44	3.67	0.80	0.92	0.025
Month 45	45	3.75	0.82	0.94	0.020
Month 46	46	3.83	0.83	0.95	0.016
Month 47	47	3.92	0.85	0.95	0.013
Month 48	48	4.00	0.86	0.96	0.010
Month 49	49	4.08	0.87	0.97	0.008
Month 50	50	4.17	0.88	0.97	0.006
Month 51	51	4.25	0.89	0.98	0.005
Month 52	52	4.33	0.90	0.98	0.003
Month 53	53	4.41	0.91	0.98	0.003
Month 54	54	4.50	0.92	0.99	0.002
Month 55	55	4.58	0.92	0.99	0.001
Month 56	56	4.66	0.93	0.99	0.001
Month 57	57	4.75	0.94	0.99	0.001
Month 58	58	4.83	0.94	0.99	0.000
Month 59	59	4.91	0.95	0.99	0.000
Month 60	60	5.00	0.95	1.00	0.000
Month 61	61	5.08	0.95	1.00	0.000
Month 62	62	5.16	0.95	1.00	0.000
Month 63	63	5.25	0.95	1.00	0.000
Month 64	64	5.33	0.95	1.00	0.000
Month 65	65	5.41	0.95	1.00	0.000
Month 66	66	5.50	0.95	1.00	0.000
Month 67	67	5.58	0.95	1.00	0.000
Month 68	68	5.66	0.95	1.00	0.000
Month 69	69	5.75	0.95	1.00	0.000
Month 70	70	5.83	0.95	1.00	0.000
Month 71	71	5.91	0.95	1.00	0.000
Month 72	72	6.00	0.99	1.00	0.000
Month 73	73	6.08	0.99	1.00	0.000
Month 74	74	6.16	0.99	1.00	0.000
Month 75	75	6.25	0.99	1.00	0.000
Month 76	76	6.33	0.99	1.00	0.000
Month 77	77	6.41	0.99	1.00	0.000
Month 78	78	6.50	0.99	1.00	0.000
Month 79	79	6.58	0.99	1.00	0.000
Month 80	80	6.66	0.99	1.00	0.000
Month 81	81	6.75	0.99	1.00	0.000
Month 82	82	6.83	0.99	1.00	0.000
Month 83	83	6.91	0.99	1.00	0.000
Month 84	84	7.00	0.99	1.00	0.000
Month 85	85	7.08	0.99	1.00	0.000
Month 86	86	7.16	0.99	1.00	0.000
Month 87	87	7.25	0.99	1.00	0.000
Month 88	88	7.33	0.99	1.00	0.000
Month 89	89	7.41	0.99	1.00	0.000
Month 90	90	7.50	0.99	1.00	0.000
Month 91	91	7.58	0.99	1.00	0.000
Month 92	92	7.66	0.99	1.00	0.000
Month 93	93	7.75	0.99	1.00	0.000
Month 94	94	7.83	0.99	1.00	0.000
Month 95	95	7.91	0.99	1.00	0.000
Month 96	96	8.00	1.00	1.00	0.000
Project End			1.00	1.00	0.000

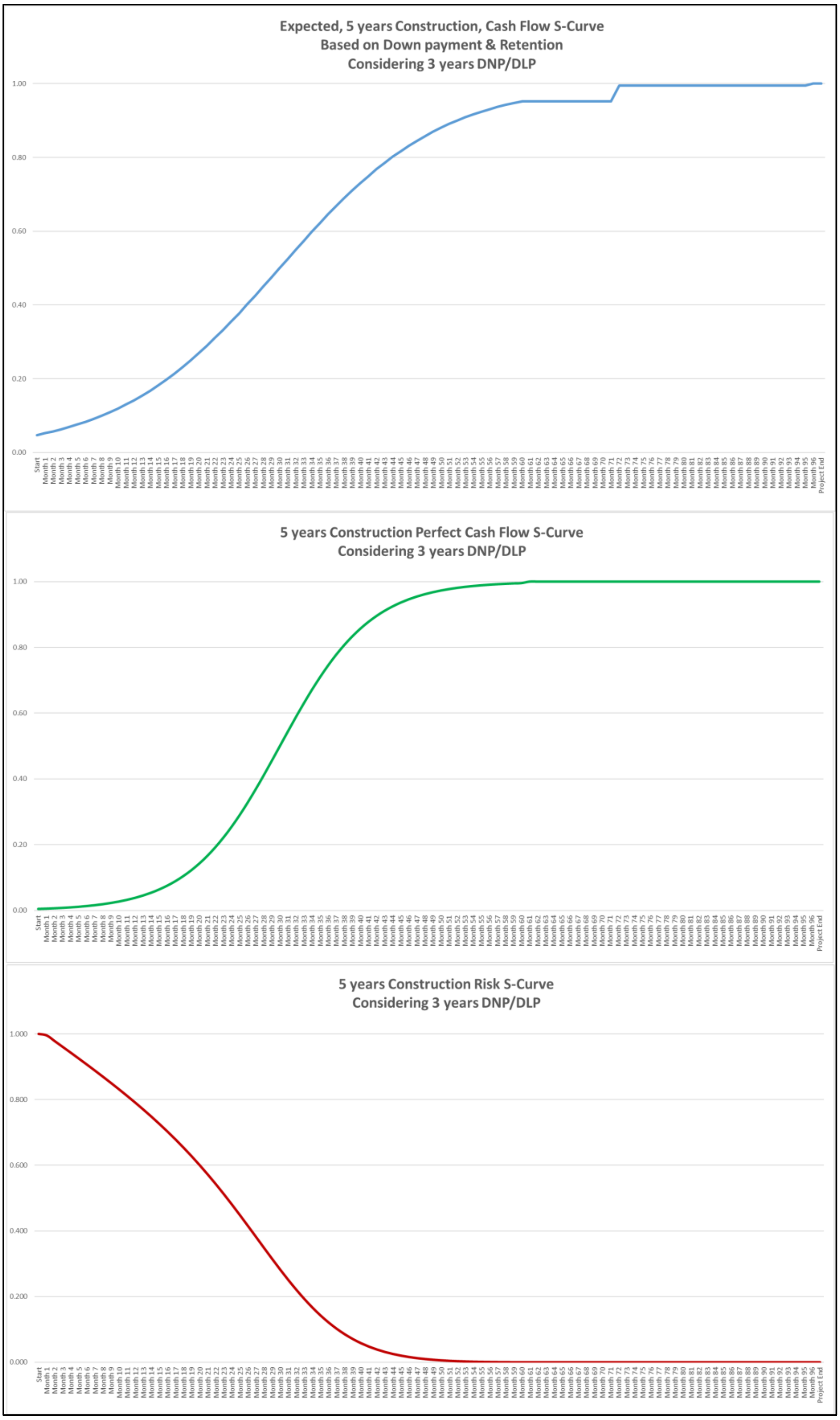

Figure 12. *Trending 5 years construction Cash flow and Risk S-Curves based on DNP/DLP without retention bond.*

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4.4. Cash Flow Area Method Approaches

According to previous research, construction projects' cash flow estimation studies approach area method analysis, as shown in Figure 3 (Konior & Szóstak 2020). This approach is achieved by plotting previous similar projects S-Curves and create an area that includes all potted points (Konior & Szóstak 2020). It is then merged with the estimated cash flow to create an updated area, including actual and estimated cash flows (Konior & Szóstak 2020). This area is used to identify construction projects' cash flow S-Curve range in each time step (Cristóbal 2017; Wang et al. 2016; Odeyinka, Lowe & Kaka 2013; Konior & Szóstak 2020). Researchers stated that there are other methods and models for cash flow estimation such as mathematical equations, building information modelling, and baseline forecast (Cristóbal 2017; Wang et al. 2016; Odeyinka, Lowe & Kaka 2013; Konior & Szóstak 2020). They are too complicated and do not help plan or support construction project management (Konior & Szóstak 2020).

In this part of the article, cash flow tolerance possibility estimation based on the chosen verification projects 1, 2, and 3 are analysed as per summary tables 12 to 15. The area analysis is based on 3 actual projects cash flow and the developed cash flow s-curve. Therefore, this research study approaches the cash flows-curve area method to provide "the easy-to-apply" cash flow model (Konior & Szóstak 2020, p. 19). This will support planning and managing the project (i.e., monitoring and control (Konior & Szóstak 2020). It is proved that this approach is a helpful tool (i.e., model) for both investors (i.e., clients) and contractors (Konior & Szóstak 2020). The following equations 10 to 16 are used to create tables 12 to 15.

$$X3 = X1 - X2 \quad (10)$$

$$X4 = \text{Absolute } (X3+X1) \quad (11)$$

$$X5 = \text{Absolute } (X3-X1) \quad (12)$$

$$X6 = X4 - X5 \quad (13)$$

$$X7 = \text{MAX } X4 \text{ value of all selected real projects} \quad (14)$$

$$X8 = \text{MIN } X5 \text{ value of all selected real projects} \quad (15)$$

$$X9 = X7 - X8 \quad (16)$$

X1 is the Estimated Cash Flow simple s-curve.

X2 is the Actual Project Paid Cash Flow for Housing Project.

X3 is the Deference Between Actual and Estimated Cash Flow.

X4 is the Project's MAX S-Curve Absolute Error.

X5 is the Project's MIN S-Curve Absolute Error.

X6 is the Project's Error of Each Time Step Cash Flow.

X7 is the Combined MAX S-Curve Absolute Error.

X8 is the Combined MIN S-Curve Absolute Error.

X9 is the Total Cash Flow Error (Time Step Cash Flow Fluctuation Possibility).

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Table 12. *It is showing verification projects used for this research area method and how much cost cash flow can fluctuate each time step including project 1.*

Housing Project 1						
Years	**X1**	**X2**	**X3**	**X4**	**X5**	**X6**
0	2.24%	0.00%	2.24%	4.47%	0.00%	4.47%
0.125	3.11%	3.51%	-0.40%	3.51%	2.70%	0.81%
0.25	4.30%	5.72%	-1.42%	5.72%	2.88%	2.84%
0.375	5.92%	8.21%	-2.29%	8.21%	3.64%	4.57%
0.5	8.11%	10.28%	-2.17%	10.28%	5.94%	4.34%
0.625	11.01%	12.79%	-1.78%	12.79%	9.22%	3.57%
0.75	14.77%	16.58%	-1.81%	16.58%	12.96%	3.62%
0.875	19.55%	18.43%	1.12%	20.66%	18.43%	2.23%
1	25.40%	19.35%	6.05%	31.45%	19.35%	12.10%
1.125	32.31%	20.76%	11.55%	43.86%	20.76%	23.10%
1.25	40.09%	35.39%	4.70%	44.80%	35.39%	9.41%
1.375	48.41%	42.52%	5.89%	54.30%	42.52%	11.78%
1.5	56.82%	55.25%	1.57%	58.40%	55.25%	3.15%
1.625	64.87%	75.56%	-10.69%	75.56%	54.18%	21.38%
1.75	72.16%	82.72%	-10.56%	82.72%	61.59%	21.13%
1.875	78.45%	84.49%	-6.04%	84.49%	72.40%	12.09%
2	83.65%	89.76%	-6.11%	89.76%	77.54%	12.22%
2.125	87.80%	90.75%	-2.95%	90.75%	84.86%	5.89%
2.25	91.03%	91.44%	-0.41%	91.44%	90.62%	0.82%
2.375	93.48%	92.73%	0.75%	94.24%	92.73%	1.51%
2.5	95.31%	93.72%	1.59%	96.91%	93.72%	3.19%
2.625	96.67%	94.34%	2.33%	98.99%	94.34%	4.65%
2.75	97.65%	95.70%	1.95%	99.61%	95.70%	3.91%
2.875	98.37%	97.72%	0.65%	99.02%	97.72%	1.30%
3	100.20%	100.00%	0.20%	100.41%	100.00%	0.41%

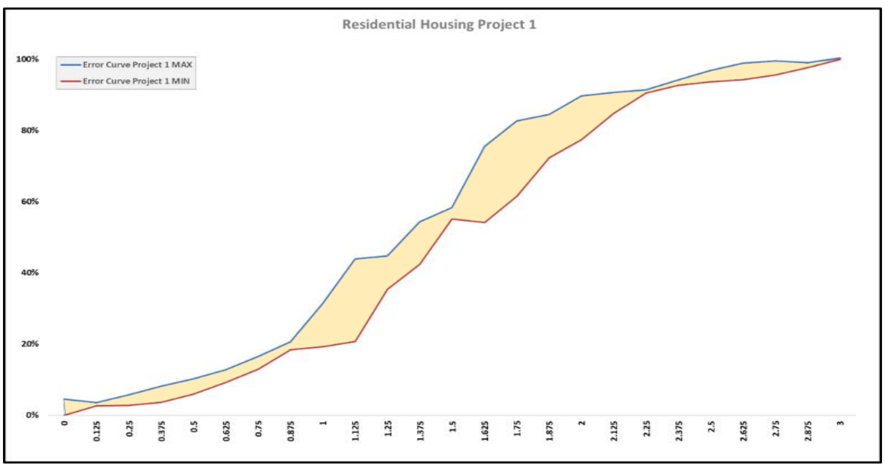

Figure 13. *Cash flow area method range of verification project 1 (i.e., within the highlighted area).*

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Table 13. *It is showing verification projects used for this research area method and how much cost cash flow can fluctuate each time step including project 2.*

Housing Project 2						
Years	**X1**	**X2**	**X3**	**X4**	**X5**	**X6**
0	2.24%	3.00%	-0.76%	3.00%	1.47%	1.53%
0.125	3.11%	4.42%	-1.31%	4.42%	1.79%	2.63%
0.25	4.30%	5.05%	-0.75%	5.05%	3.55%	1.50%
0.375	5.92%	5.95%	-0.03%	5.95%	5.90%	0.05%
0.5	8.11%	7.15%	0.96%	9.07%	7.15%	1.92%
0.625	11.01%	9.25%	1.76%	12.76%	9.25%	3.51%
0.75	14.77%	12.52%	2.25%	17.02%	12.52%	4.50%
0.875	19.55%	17.76%	1.79%	21.33%	17.76%	3.57%
1	25.40%	28.51%	-3.11%	28.51%	22.29%	6.22%
1.125	32.31%	34.70%	-2.39%	34.70%	29.92%	4.78%
1.25	40.09%	39.98%	0.11%	40.21%	39.98%	0.23%
1.375	48.41%	46.73%	1.68%	50.09%	46.73%	3.36%
1.5	56.82%	52.35%	4.47%	61.30%	52.35%	8.95%
1.625	64.87%	64.91%	-0.04%	64.91%	64.83%	0.08%
1.75	72.16%	71.09%	1.06%	73.22%	71.09%	2.13%
1.875	78.45%	77.28%	1.17%	79.62%	77.28%	2.34%
2	83.65%	83.46%	0.19%	83.84%	83.46%	0.37%
2.125	87.80%	86.00%	1.80%	89.61%	86.00%	3.61%
2.25	91.03%	88.00%	3.03%	94.06%	88.00%	6.06%
2.375	93.48%	88.50%	4.98%	98.47%	88.50%	9.97%
2.5	95.31%	89.65%	5.67%	100.98%	89.65%	11.33%
2.625	96.67%	95.83%	0.83%	97.50%	95.83%	1.66%
2.75	97.65%	97.00%	0.65%	98.31%	97.00%	1.31%
2.875	98.37%	101.00%	-2.63%	101.00%	95.74%	5.26%
3	100.20%	103.00%	-2.80%	103.00%	97.41%	5.59%

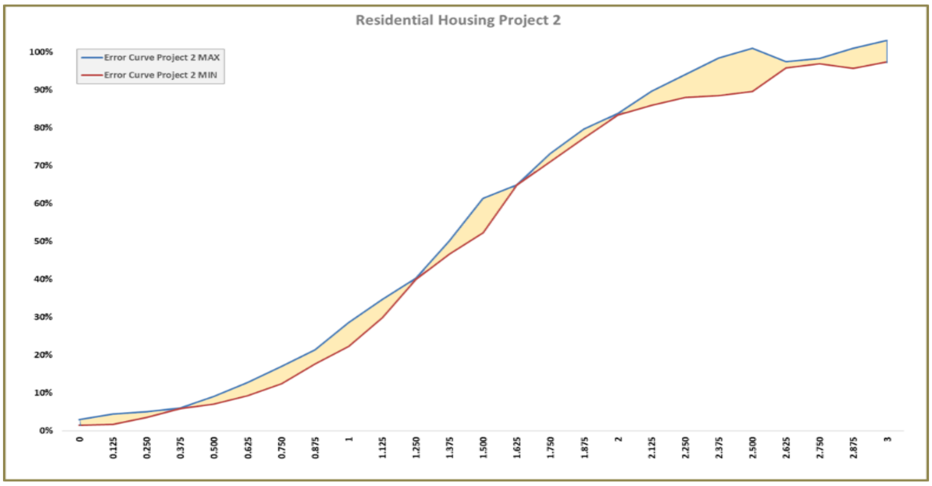

Figure 14. *Cash flow area method range of verification project 2 (i.e., within the highlighted area).*

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Table 14. *It is showing verification projects used for this research area method and how much cost cash flow can fluctuate each time step including project 3.*

Housing Project 3						
Years	**X1**	**X2**	**X3**	**X4**	**X5**	**X6**
0	2.24%	0.10%	2.14%	4.37%	0.10%	4.28%
0.125	3.11%	0.10%	3.01%	6.11%	0.10%	6.02%
0.25	4.30%	2.87%	1.43%	5.73%	2.87%	2.86%
0.375	5.92%	4.35%	1.58%	7.50%	4.35%	3.15%
0.5	8.11%	6.34%	1.77%	9.88%	6.34%	3.54%
0.625	11.01%	8.86%	2.15%	13.15%	8.86%	4.30%
0.75	14.77%	12.23%	2.54%	17.32%	12.23%	5.09%
0.875	19.55%	15.91%	3.64%	23.18%	15.91%	7.27%
1	25.40%	20.22%	5.18%	30.58%	20.22%	10.36%
1.125	32.31%	34.51%	-2.20%	34.51%	30.11%	4.40%
1.25	40.09%	39.14%	0.96%	41.05%	39.14%	1.91%
1.375	48.41%	44.04%	4.37%	52.79%	44.04%	8.75%
1.5	56.82%	49.08%	7.75%	64.57%	49.08%	15.50%
1.625	64.87%	55.56%	9.31%	74.18%	55.56%	18.62%
1.75	72.16%	61.83%	10.33%	82.49%	61.83%	20.66%
1.875	78.45%	68.00%	10.45%	88.90%	68.00%	20.90%
2	83.65%	72.36%	11.29%	94.94%	72.36%	22.59%
2.125	87.80%	77.09%	10.72%	98.52%	77.09%	21.44%
2.25	91.03%	80.33%	10.71%	101.74%	80.33%	21.41%
2.375	93.48%	81.91%	11.57%	105.05%	81.91%	23.14%
2.5	95.31%	85.67%	9.64%	104.96%	85.67%	19.29%
2.625	96.67%	87.55%	9.12%	105.78%	87.55%	18.24%
2.75	97.65%	88.03%	9.62%	107.27%	88.03%	19.24%
2.875	98.37%	93.10%	5.27%	103.64%	93.10%	10.55%
3	100.20%	100.097%	0.11%	100.31%	100.10%	0.21%

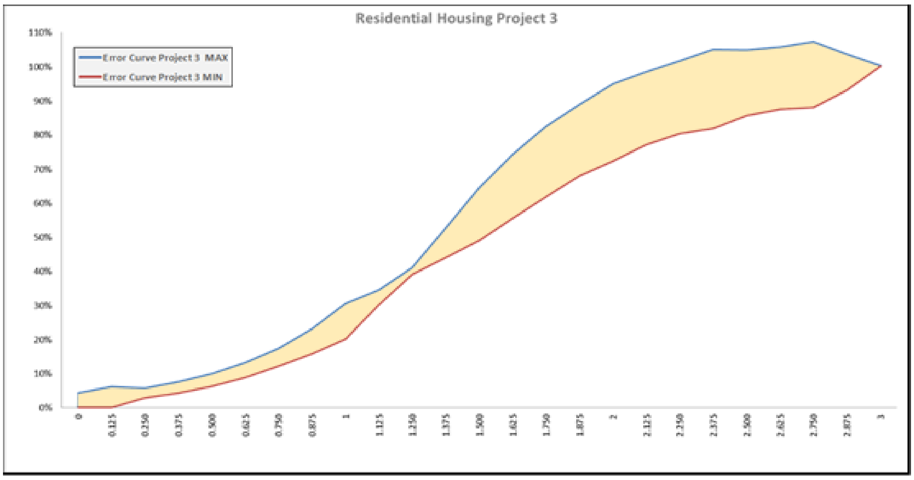

Figure 15. *Cash flow area method range of verification project 3 (i.e., within the highlighted area).*

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Table 15. It is showing ALL verification projects and how much cost cash flow can fluctuate each time step.

All 3 Housing Projects				
Years	**X1**	**X7**	**X8**	**X9**
0	2.24%	4.47%	0.00%	4.47%
0.125	3.11%	6.11%	0.10%	6.02%
0.25	4.30%	5.73%	2.87%	2.86%
0.375	5.92%	8.21%	3.64%	4.57%
0.5	8.11%	10.28%	5.94%	4.34%
0.625	11.01%	13.15%	8.86%	4.30%
0.75	14.77%	17.32%	12.23%	5.09%
0.875	19.55%	23.18%	15.91%	7.27%
1	25.40%	31.45%	19.35%	12.10%
1.125	32.31%	43.86%	20.76%	23.10%
1.25	40.09%	44.80%	35.39%	9.41%
1.375	48.41%	54.30%	42.52%	11.78%
1.5	56.82%	64.57%	49.08%	15.50%
1.625	64.87%	75.56%	54.18%	21.38%
1.75	72.16%	82.72%	61.59%	21.13%
1.875	78.45%	88.90%	68.00%	20.90%
2	83.65%	94.94%	72.36%	22.59%
2.125	87.80%	98.52%	77.09%	21.44%
2.25	91.03%	101.74%	80.33%	21.41%
2.375	93.48%	105.05%	81.91%	23.14%
2.5	95.31%	104.96%	85.67%	19.29%
2.625	96.67%	105.78%	87.55%	18.24%
2.75	97.65%	107.27%	88.03%	19.24%
2.875	98.37%	103.64%	93.10%	10.55%
3	100.20%	103.00%	97.41%	5.59%

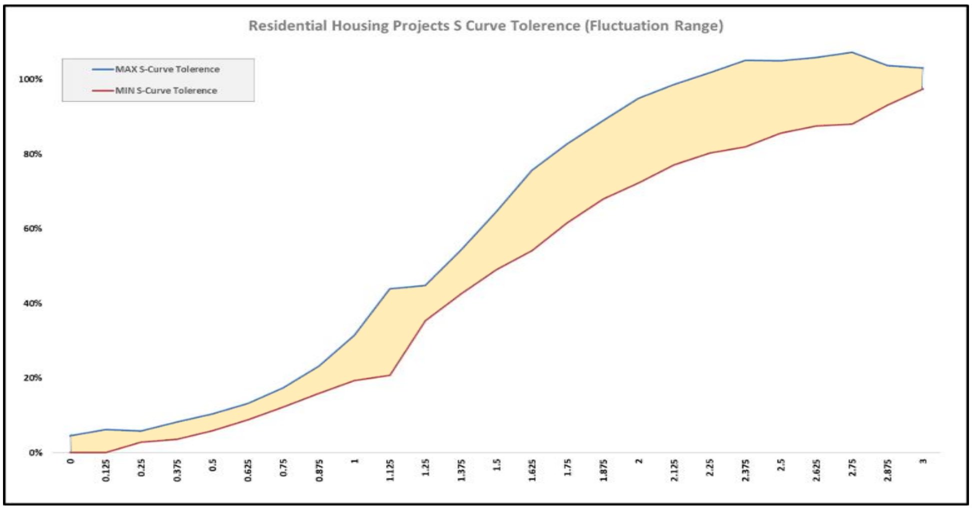

Figure 16. *Cash flow area method range of ALL verification project 1, 2 & 3 (i.e., within the highlighted area).*

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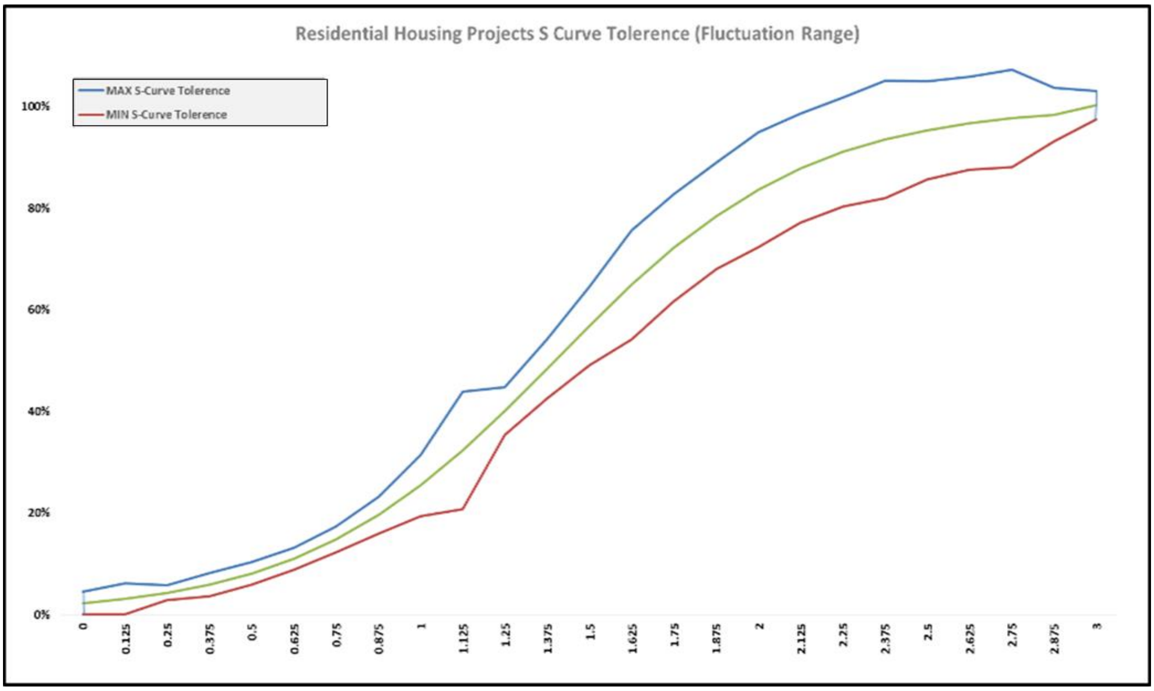

Figure 17. *Cash flow area range of total verification projects 1, 2 and 3 including maximum limits, minimum limits, and estimated cash flow S-Curve.*

However, this research is adding to the body of knowledge a new area method approach based on having a lower number than 30 projects. This research will include the maximum absolute value from actual and estimated curves at each time step. The highest limit contains all projects (i.e., three projects) and cash flow estimating curve shown in Figures 14, 15, 16, and 17. However, the final total tolerance range for better housing projects cash flow planning is shown in Figure 8. Nevertheless, those curves are based on three chosen projects only, and it is recommended to increase it to at least 30 (Konior & Szóstak 2020). Then, validate it using SPSS to exclude the outlier projects (Konior & Szóstak 2020). As more projects enter the process, the created area range in Figures 17 and 18 will be more accurate and include all similar projects' cash flow possibilities as shown in figure 8 which is done in previous research for hotel projects (Konior & Szóstak 2020).

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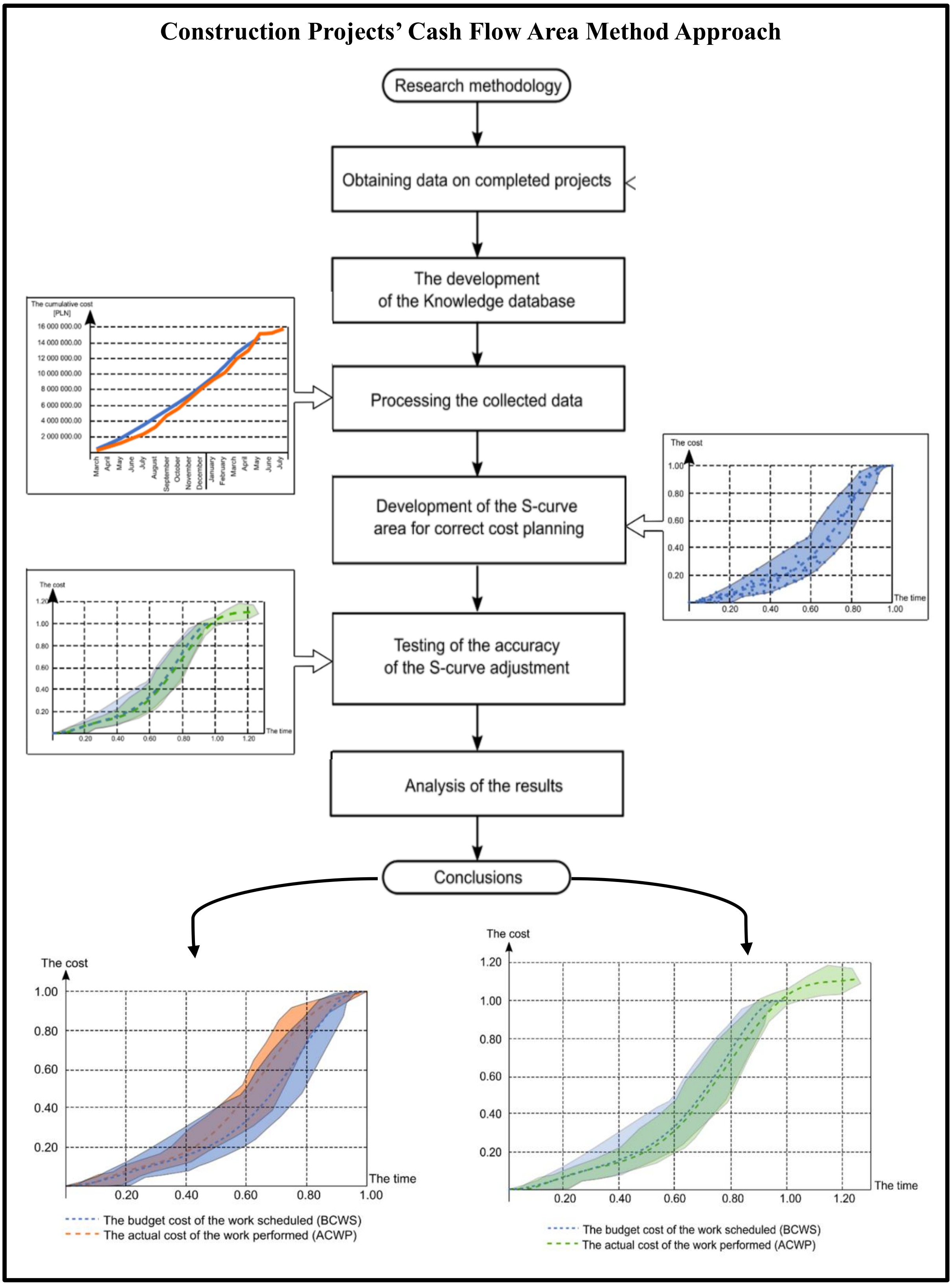

Figure 18: *Construction projects' cash flow area method approach for accurate estimation in each time step over project's duration for hotel projects: an example for the existing previous area method approach (i.e., at least 30 projects) (Konior & Szóstak 2020).*

5. FINDINGS

To sum up, this article introduced cash flow and risk s-curves establishment from client perspective using contracts tender value at the preconstruction stage. The mathematical calculations and figures explained how each step of the development was approached and completed. However, the originality, implications, and limitations will be presented as the following.

6. CONCLUSION AND RECOMMENDATION

To sum up, this article introduced cash flow and risk s-curves establishment from client perspective using contracts tender value at the preconstruction stage. The mathematical calculations and figures explained how each step of the development was approached and completed. However, the originality, implications, and limitations will be presented as the following.

6.1. Originality

According to the best knowledge of the author, there is no previous research approached standardizing cash flow and risk s-curves using simple logistic curve from client perspective at the preconstruction stage. Also, no previous research included the new approach of creating cash flow estimation area.

6.2. Theoretical Implications

This article is providing three main theoretical implications. It is presenting a new simple approach to create (1) construction cash flow increasing s-curve and (2) construction risk decreasing s-curve. Then, this research is introducing a new simple approach to establish construction project's cash flow stochastic values range (i.e., area method). The risk decreasing s-curve is considered the risk behaviour during construction; however, future research can use this behaviour to measure risk impact during construction stage.

6.3. Practical Implications

This article provides two important practical implications. First, the estimation cash flow s-curve is developed mathematically using the contract tender value solely. This will facilitate to experts to evaluate construction project's budget and actual-cost s-curves. The developed cost-percentage s-curve is based on zero-risk impact and is from client perspective at the preconstruction stage; however, experts in the professional industry will have the ability to adapt risks cost for better cash flow evaluation. The risk impact will be based on multiplying the collected risks probabilities by the risk behaviour s-curve. Then, multiply the risk impact percentage by the spent cash quantity in each time step (i.e., spent cash = cash flow s-curve multiplied by the contract tender value at the preconstruction stage). Finally, add the risk impact to the estimated zero-risk cash flow s-curve in terms of money. Nevertheless, the developed area method can adapt as many historical projects as possible to increase the estimation accuracy and minimize potential errors. The provided methods can be adapted to fit deferent construction lifetime (i.e., equal to 3 years in this article).

6.4. Limitations and Future Research Recommendations

The limitations of this study are summarized as the following. Cash flow increasing S-Curve in this research, is analysed using three projects real housing projects. This is by identifying the yield absolute maximum points upper or lower the middle risk S-Curve. It will create a stochastic approach by developing a mirror area around the model's mean S-Curve values. Moreover, each time step will possibly move up and down within the identified area limits. However, this research agrees with previous researchers to increase the number of projects, in future research, to be more than 30 and establish a more accurate stochastic cash flow estimation.

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