Section 1: activities classification (stage 2)

The stage 2 of the framework was designed with the aim to classify the activities which were determined in the value creation activity map. The weights which were calculated by AHP were scaled in a way to set the maximum weight to 9 and at the end the obtained numbers were showed in the paper. The final weights are shown in the Table I

Table I, Weights for the stage 2 of the framework

	Uniqueness weights	Collectiveness weights
EMS	8.75	7.03
RMS	8.00	4.71
FMS	9	9
HRMS	4.87	6.04
LPMS	4.70	3.30
LCMS	3.38	7.94
SSMS	8.42	3.30
E-LMS	5.86	3.30
IPIMS	8.25	7.94
TMCSM	7.26	7.94
DRBIS	8.75	6.04
CSMS	5.28	3.72

Section 2: mathematical model implementation

In this section, the detail information about the mathematical model including parameters and equations are provided. Totally, there are 12 modules which should be assigned to the alternatives. According to stage 2 of the procedure, 6 modules selected for internalization. Also, E-LMS has just one alternative according to the stage 4 of the framework, where unqualified alternatives were omitted from the rest of procedure. Then, there are 6 modules which should be assigned to the alternatives in stage 5 and by mathematical model. These modules are listed in Table II. In the following, the required explanations about objectives and constraints are provided.

Objective functions: As mentioned before, there are two objective functions in the multi objective linear programming model, named: (1) RBV objective, (2) TCT objective. The required parameters for these two objectives are illustrated in Table II which were calculated by AHP method. The objectives formed as showed in equation (1) and (2) in a straight forward manner. Uniqueness and collectiveness parameters are estimation of alternative's resources specifics which were calculated by AHP, and also production and transaction costs are estimation of cost attributes by AHP technique.

$$Z_1 = f_1(X_{ij}) = \sum_{i=1}^{6}\sum_{j=1}^{3}(0.65Un_{ij}.X_{ij} + 0.35\,Co_{ij}X_{ij}) \qquad equation\ (1)$$

$$Z_2 = f_2(X_{ij}) = \sum_{i=1}^{6}\sum_{j=1}^{3}(0.65Pr_{ij}.X_{ij} + 0.35\,Tr_{ij}X_{ij}) \qquad equation\ (2)$$

Table II, objective functions' parameters

	Uniqueness			Collectiveness			Production cost			Transaction cost				
alternatives	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**		
RMS	0.48	0.11	0.41	0.54	0.30	0.16	0.21	0.55	0.24	0.14	0.13	0.73	W_1	0.65
SSMS	0.39	0.44	0.17	0.26	0.41	0.33	0.24	0.14	0.63	0.39	0.17	0.44	W_2	0.35
LPMS	0.09	0.62	0.29	0.65	0.29	0.06	0.19	0.17	0.63	0.39	0.17	0.44	W_1'	0.65
HRMS	0.16	0.69	0.15	0.63	0.19	0.17	0.46	0.13	0.42	0.16	0.19	0.66	W_2'	0.35
LCMS	0.66	0.25	0.10	0.18	0.68	0.14	0.13	0.14	0.73	0.26	0.41	0.33		
CSMS	0.60	0.28	0.13	0.30	0.54	0.16	0.10	0.25	0.66	0.17	0.26	0.57		

Constraints: There are six set of constraints which are showed below. The first set is showed in equation (3) and consists of 6 constraints. The equation (4) and (5) tried to model the due dates. It is noticeable that the times should be considered for all modules, not only for the six modules that are under assessment. The equation (6) is related to total budget. The required parameters for equations (4) to (6) are provided in Table III. The equation (8) is related to specific situation between alternatives that cause the hub managers to avoid gathering them in a portfolio.

$$equation\ (3)\quad \sum_{j=1}^{3} X_{ij} = 1. \quad \forall\, i \in \{1.2.3\,..6\}$$

$$equation\ (4)\ \mathrm{DUE\ (i)} \leq \mathrm{DUE(k)} - \sum_{j=1}^{3} T_{kj}.X_{kj}. \quad \forall (i.\ k) \in H$$

$$equation\ (5)\ DUE(n) = 14;$$

$$equation\ (6)\quad \sum_{i=1}^{6}\sum_{j=1}^{3} C_{ij}.X_{ij} \leq 1800$$

$$equation\ (7)\quad X_{11} + X_{41} \leq 1. \quad X_{53} + X_{43} \leq 1$$

Table III, constraint's parameters

	Costs				Times					
alternatives	**1**	**2**	**3**		**1**	**2**	**3**		**1**	
RMS	474	270	456	**RMS**	2.2	3.8	2	**EMS**	1.8	Total budget
SSMS	343	389	169	**SSMS**	3.4	2	2.4	**FMS**	2.4	
LPMS	291	297	132	**LPMS**	2.2	0.8	1	**E-LMS**	1.8	1800
HRMS	244	393	263	**HRMS**	1.2	2.4	1	**IPIMS**	2	Final due date
LCMS	261	259	80.4	**LCMS**	2	1	0.8	**TMCSM**	2.2	
CSMS	217	180	82.8	**CSMS**	1.2	1	1.8	**DRBIS**	1.8	14