Resulting effects in the evaluation of innovative technology implementation by hotel organisations

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Abstract. The article describes the problem of the reflection of resulting effects in the innovative activity of hotel organisations. Despite the special attention and interest in the issue under discussion, a unified approach to the category of "resulting effects" of innovative technology application regarding hotel organisations has not been developed in the research community so far that would take into account the specific characteristics of their activities. A number of existing definitions limit innovative activity to a set of actions for the development and implementation of technologically new services without considering the effects of carrying out innovative processes, the ability to maintain a certain level of innovative activity and availability of a resource complex. The content of resulting effects is described based on the group of indicators. The authors build the stochastic graph of indicators of resulting effects in the innovative processes of hotel organisations. The proposed technique was tested in ten hotel organisations of the resort city of Sochi.

The tourism business, in particular its hotel sector, is one of the economy segments that is the most susceptible to the impact of a pandemic. The tourism sector comes up to 10% of gross domestic product and the employed in large developed countries and its rate reaches a third of the entire economy in small island states. In some countries, macroeconomic stability also extremely depends on the industry condition since inbound tourism forms up to 40-50% of all export earnings in many ways. Due to the current lockdown measures, the Russian tourism industries will be provided with the conditions in 2021 which are similar to protective measures; the reason is that the largest resorts imposed an "embargo" on the export of their tourism services closing the borders.

Such a negative influence of the pandemic on the tendency to travel abroad is believed to occur not only in 2021 but also in subsequent years. These processes will be accompanied by increased demand for relatively budget recreation options. In the countries

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bordering warm seas and having significant recreational resources, such as Russia, there is a considerable potential for the revenue growth of the tourism industry; in this regard, the positive effect will spread beyond 2021.

Thus, innovative technology is getting particularly important in Russia both in rendering services to guests and in managing the income of hotel organisations hosting tourists.

Nowadays, hotel guests are discerning, critical and demanding. To provide quality service to such sophisticated guests, there is a need for a special approach that goes beyond the traditional technologies of the hospitality industry requiring innovative technologies and tools for their implementation. Tightening service standards, an individual approach, and a guarantee of the highest quality of delivered goods and services are currently performing the role of effective levers for the management of profit and customer loyalty.

In view of this, one of the directions to apply the innovative technologies in the income management of hotel organisations is the determination of the resulting effects (RE) arising from the intensification of innovation processes, including innovative potential (IP), innovation sustainability (IS) and the intensity of innovative activity (IA). The interaction of these categories is shown in Figure 1.

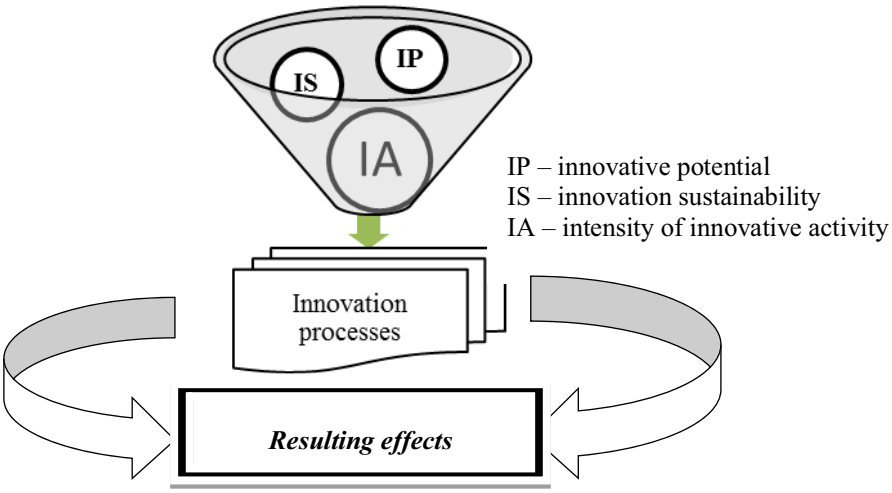

Fig. 1. Resulting effects of the implementation of innovative technology in hotel organisations.

All indicators characterising the use of innovative technologies of hotel organisations are interrelated and interdependent. The relationship between some of them is direct, between others - indirect [1].

The resulting effect of innovation processes is a multidimensional definition [1]. In the authors' point of view, this effect size is directly determined by the expected effectiveness, manifesting itself within the following approaches:

- production and technological approach,
- innovative and economic approach,
- socially-oriented approach [2].

The content of resulting effects of the implementation of innovation processes in the context of the above mentioned approaches is presented in Table 1.

To study the mutual influence of elements of innovation processes of hotel organisations with the resulting effects from the implementation of innovation processes, the authors choose the technique of stochastic factor analysis.

Table 1. Content of resulting effects of the implementation of innovation technology in the activity of hotel organisations.

Indicators of production and technological resulting effect of the implementation of innovation processes (REPT)
Share of new information technology
Coefficient of production automation
Share of innovative technological processes
Tourist flow
Income per room and night
Annual average coefficient of hotel occupancy
Duration of stay per room
Net income per room
Cost-effectiveness of rendering hotel services
Income per room
Average income per guest
Indicators of innovative and economic resulting effect of the implementation of innovation processes (REI)
Capital investment in the implementation of innovation processes
Net present cost of innovation processes
Payback from innovation processes
Cost-effectiveness index of innovation processes
Indicators of socially-oriented resulting effect of the implementation of innovation processes (RESH)
Earnings gain of staff
Net income per employee
Cost-effectiveness of human resources
Ecological security and safety of working environment

The application of factor analysis, especially the research methods of dimension of selected factor groups and the structure of the matrices of their co-variance and correlation, enables:

– to study and measure comprehensively how the value of resulting indicators of the implementation of innovation processes depends on influencing factors;

– to determine the linear statistical relations of correlation and identify the factors, providing their existence [3].

The choice of stochastic (correlation) factor analysis, based on graphical and set-theoretical description through structuring the factors of innovative activity and indicators of the resulting effect of the implementation of innovation processes, as a methodological approach is due to the multidimensionality and variability of these factors and indicators, as well as their interconnection and interdependence. However, the nature of their relationship is incomplete and probabilistic, and a lack of complete quantitative information is specific to a number of indicators which makes it necessary to use qualitative analysis to establish qualitative (cause-effect) relations between them [4]. The structuring process is completed by creating a stochastic factor model.

The analysis procedure involves combining the factors of innovative activity correlating in a greater degree with each other and the indicators of the resulting effects. In such a case, the correlation level of one factor with different indicators of the resulting effect can vary significantly. The procedure results in determination of latent variables [5].

For the mathematical description of the factor model, its corresponding correlation matrix is created and some stages of factor analysis and stochastic modelling are carried out.

Table 2. Stochastic matrix of indicators of the resulting effects.

X / Y	ICp	HEPS	DPS	TPC	IPRC	TPIC	CREC	TRFA	AUR	MANR	HSP	PSR	IGR	IFS	FII	CHSS	REPT	REI	RESH
ICp	0	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
HEPS	1	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
DPS	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
TPC	1	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
IPRC	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	1	0
TPIC	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	0	1	0
CREC	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	1	0
TRFA	0	0	0	0	1	0	0	0	1	0	1	0	1	0	0	0	0	1	0
AUR	0	0	0	0	1	0	1	0	0	1	0	0	1	1	1	1	0	1	0
MANR	0	0	0	0	0	0	1	1	1	0	0	0	1	1	1	1	0	1	0
HSP	0	0	0	0	0	1	0	1	0	0	0	0	1	1	1	1	1	0	1
PSR	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
IGR	0	0	0	0	0	1	0	0	0	1	1	0	0	1	1	1	0	1	0
IFS	0	0	0	0	0	1	0	1	1	1	1	0	1	0	1	1	1	1	0
FII	0	0	0	0	0	1	0	1	1	1	1	0	1	1	0	1	1	1	0
CHSS	0	0	0	0	0	1	0	1	0	0	1	0	0	1	1	0	1	0	0
REPT	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	1	0	1	0
REI	0	0	0	0	1	1	1	1	1	1	1	0	1	1	1	0	1	0	0
RESH	1	1	1	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0

At the first stage, the authors propose to develop a stochastic matrix of indicators of the resulting effects (Table 2). In the next step, the number of ones in each row and column is counted, taking into account the calculation of dimension and arrangement of indicators in descending order (Table 3).

The graphic representation of the determined links of the selected indicators and the resulting effects is depicted in Figure 2.

The conducted analysis shows the multidimensionality of the concept of "innovation processes of hotel organisations" and allows to characterise the interrelation of its components.

The majority of relations of indicators of the innovative and economic resulting effect of innovation processes implemented by hotel organisations (REI) enable us to conclude about the most meaningful nature of this component which forms the core of the correlation graph and represents a latent variable. This fact leads to the possibility and need to isolate REI as a higher order variable.

Table 3. Ranking of stochastic relations of indicators of resulting effects of hotel organisations.

X	10	9	9	7	7	7	6	5	5	5	4	4	4	4	4	4	4	3	3
	REI	HSP	IFS	TRFA	IGR	FII	CHSS	MANR	TPIC	AUR	RESH	ICp	HEPS	DPS	TPC	PSR	REPT	IPRC	CREC
Y	9	8	8	7	7	7	7	6	5	5	5	4	4	4	4	4	4	3	3
	REI	IFS	FII	AUR	MANR	HSP	IGR	TPIC	CHSS	RESH	ICp	HEPS	DPS	TPC	TRFA	PSR	REPT	IPRC	CREC

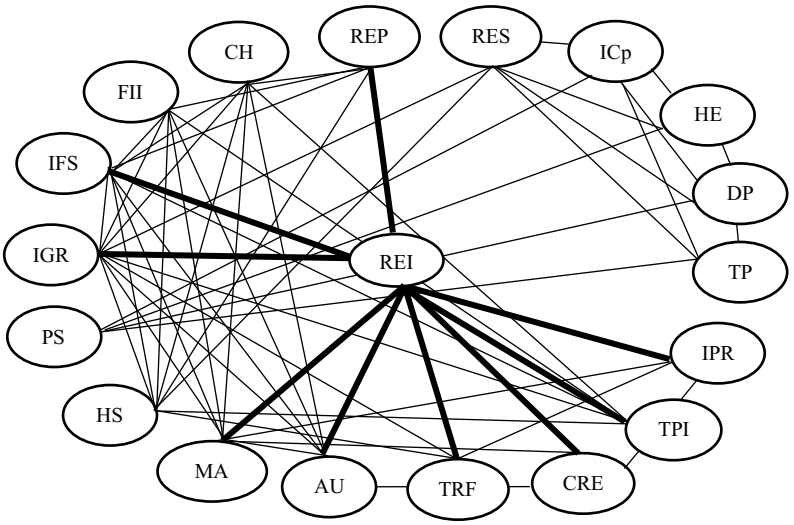

Fig. 2. Stochastic graph of indicators of resulting effects in the innovation processes of hotel organisations.

The indicators of the share of funding for innovative activities in the revenue from the sale of hotel services (IFS) and the share of funding for adopted innovations within the total volume of funded innovations (FII) are similar in the number of linear links and have a high correlation coefficient.

Among the elements of innovation activity, the indicators of innovation intensity have the greatest rate of correlation. The lowest level of correlation is demonstrated by the indicators reflecting the qualitative features of staff.

The final stage ends with a quantitative assessment of the resulting effects in the evaluation of the implementation of innovative technologies by hotel organisations with regard to income management (Table 4)

Besides, the authors calculated normalised indicator values of the resulting effects for the analysed hotel organisations of the resort city of Sochi (Table 5).

For the integrated evaluation of innovative activity, the authors propose to use the integral indicators defined as the square root of the product of all relevant indicators:

$$\Sigma(IP) = \sqrt[8]{ICp * HEPS * DPS * TPC * IPRC * TPIC * CREC * TRFA}, \quad (1)$$

$$\Sigma(IS) = \sqrt[5]{AUR * MANR * HSP * PSR * IGR}, \quad (2)$$

$$\Sigma(IA) = \sqrt[3]{IFS * FII * CHSS}, \quad (3)$$

As it can be seen from Table 5, Organisation 9 (0.69) has the highest value of the integral indicator of innovative activity Σ(EIA) and Organisation 8 (0.46) shows the lowest one.

Based on the obtained values, the petal diagram is constructed depicting the highest and lowest integral levels of innovative activity among the organisations under consideration (Fig. 3).

Consequently, the research enables to conclude that innovative technology in hotel business and corresponding tools make it possible to optimise the activity of hotel subdivisions and positively influence the financial and economic activity and resulting effects in conjunction with innovative sustainability and innovative potential development considerably facilitate the optimisation of revenue management processes.

Table 4. Main groups of indicators according to the elements of ten hotel organisations.

Indicators of resulting effects		Organisation 1	Organisation 2	Organisation 3	Organisation 4	Organisation 5	Organisation 6	Organisation 7	Organisation 8	Organisation 9	Organisation 10
IP	ICp	0.09	0.06	0.09	0.07	0.20	0.08	0.07	0.14	0.06	0.07
	HEPS	0.23	0.13	0.06	0.03	0.15	0.15	0.10	0.14	0.10	0.08
	DPS	0.08	0.07	0.08	0.02	0.10	0.12	0.08	0.05	0.11	0.18
	TPC	0.39	0.28	0.28	0.04	0.05	0.20	0.45	0.16	0.83	0.05
	IPRC	0.11	0.07	0.11	0.11	0.18	0.23	0.17	0.14	0.13	0.06
	TPIC	0.01	0.04	0.02	0.10	0.07	0.06	0.00	0.05	0.06	0.06
	CREC	0.32	0.36	0.65	0.20	0.16	0.11	0.81	0.03	0.27	0.52
	TRFA	0.13	0.07	0.13	0.18	0.06	0.08	0.10	0.09	0.16	0.31
IS	AUR	0.27	0.39	0.28	0.09	0.33	0.64	0.15	0.20	0.40	0.95
	MANR	0.15	0.17	0.15	0.25	0.19	0.07	0.03	0.14	0.23	0.35
	HSP	0.10	0.10	0.16	0.03	0.00	0.08	0.24	0.08	0.10	0.02
	PSR	0.17	0.08	0.15	0.10	0.05	0.19	0.28	0.28	0.33	0.08
	IGR	0.30	0.11	0.31	0.12	0.64	0.14	0.20	0.11	0.33	0.10
IA	IFS	0.13	0.15	0.16	0.16	0.27	0.16	0.27	0.03	0.29	0.19
	FII	0.27	0.34	0.37	0.38	0.75	0.04	0.41	0.01	0.07	0.01
	CHSS	0.06	0.10	0.16	0.33	0.15	0.02	0.23	0.23	0.21	0.14

Table 5. Normalised values of indicators of resulting effects of the hotel organisations with the calculation of integral indicators [6].

Indicators		Organisation 1	Organisation 2	Organisation 3	Organisation 4	Organisation 5	Organisation 6	Organisation 7	Organisation 8	Organisation 9	Organisation 10
IP	ICp	0.44	0.31	0.47	0.35	1.00	0.42	0.33	0.72	0.31	0.36
	HEPS	1.00	0.56	0.27	0.12	0.64	0.65	0.41	0.62	0.43	0.33
	DPS	0.44	0.41	0.46	0.12	0.54	0.65	0.45	0.29	0.63	1.00
	TPC	0.47	0.34	0.33	0.05	0.06	0.24	0.54	0.19	1.00	0.06
	IPRC	0.47	0.31	0.45	0.49	0.76	1.00	0.71	0.59	0.55	0.26
	TPIC	0.14	0.42	0.23	1.00	0.73	0.65	0.03	0.50	0.65	0.66
	CREC	0.39	0.44	0.8	0.25	0.20	0.13	1.00	0.04	0.33	0.64
	TRFA	0.43	0.23	0.44	0.58	0.19	0.25	0.32	0.29	0.51	1.00
Σ(IP)		0.65	0.60	0.64	0.50	0.62	0.64	0.60	0.55	0.72	0.64
IS	AUR	0.29	0.41	0.3	0.09	0.35	0.68	0.16	0.21	0.42	1.00
	MANR	0.44	0.5	0.43	0.73	0.55	0.19	0.09	0.40	0.66	1.00
	HSP	0.44	0.42	0.7	0.11	0.02	0.32	1.00	0.32	0.42	0.09
	PSR	0.52	0.25	0.46	0.29	0.14	0.59	0.84	0.86	1.00	0.25
	IGR	0.47	0.17	0.49	0.19	1.00	0.22	0.31	0.17	0.52	0.15
Σ(IS)		0.65	0.57	0.68	0.45	0.48	0.59	0.57	0.57	0.75	0.57
IA	IFS	0.46	0.52	0.55	0.55	0.96	0.55	0.93	0.10	1.00	0.68
	FII	0.36	0.45	0.5	0.51	1.00	0.06	0.55	0.02	0.09	0.01
	CHSS	0.17	0.31	0.5	1.00	0.46	0.07	0.70	0.71	0.65	0.43
Σ(IA)		0.55	0.65	0.72	0.81	0.87	0.36	0.84	0.32	0.62	0.37
Σ(EIA)		0.61	0.61	0.68	0.57	0.64	0.51	0.66	0.46	0.69	0.51

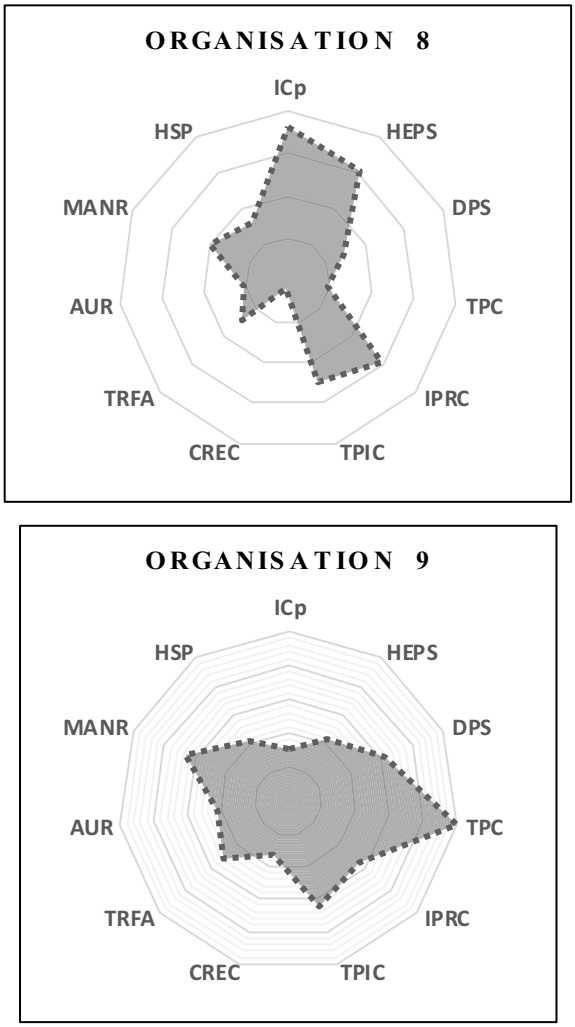

Fig. 3. Comparison of the lowest and highest levels of the integral indicators of resulting activity effects of the hotel organisations.

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