THE RISK MAPPING USING CLUSTER ANALYSIS WITHIN PANDEMIC CONTEXT: EMPIRICAL EVIDENCE FROM ROMANIA

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Abstract

During the last two years the entire world faced the worst crisis in its modern history. During the recent history, different crisis hit different regions and affected different aspects of people life (economic, social, political, terrorist and public health). Moreover, the future comes along with many challenges and different potential crisis (energetic, economic, migration, food etc.). Thus, understanding the crisis dynamic and how risk exposure is connected to human behavioral shift become more and more important for market mood understanding and business strategies adoption. Thus, the present study propose was to display an individual risk perception measurement model, considering risk probability, risk consequences and risk exposure controllability. Also, risk mapping using Cluster analysis was developed using individual risk perception and individual risk aversion using empirical data collected in the first stage of the pandemic.

Key Words: *crisis, individual risk perception, risk mapping, human behavior*

Jel Classification: O47, M21, M51

1. Introduction

During the time, researches in consumer behavior psychology, cognitive psychology and even in neuro sciences, followed different patterns in order to understand how people behave and react in risk exposure contexts. Many studies conducted in different crisis episodes, investigated how people perceive and decode risk, but also uncertainty. Anyway, uncertainty and risk are two components close connected that define any type of crisis (economic, social, terrorist, public heath etc.). Thus, how people behave under uncertainty and risky situations remain an open debate, considering that people are confronting, nowadays, with unique risk generating contexts, like pandemic. Also, psychology researchers used two approaches in explaining how risk is decoded by people. The first one consider that people perceive risk and decode it using emotions and feelings, and their behavior is based on the subjective interpretation that is a quick one, an intense one and sometimes is out of rationality. On the other hand, the second approached considered that people consider certain facts, make an analysis based on calculus in order to decode risk components and exposure. This approaches is an objective one, slower in decision making process. Still, some researchers' sustained that there is a certain combination of subjective and objective elements when people are perceive and decode risk / risk exposure.

Another important analyzed aspect in different crisis episode was the behavior shift under risk exposure. The shift intensity and directions are associated to the psychological factors as individual risk perception and individual risk aversion. In different crisis episodes, researchers empirically tested the relationship between risk perception and risk aversion. Thus, there is a certain agreement that risk perception drives risk attitude, and risk aversion is strong correlated with behavior shift. Thus, risk perception is the individual input within the internal mechanism of risk interpreting and decoding and finally behavior shift. Thus, the research questions for this study were established. What is the risk perception composition? How the risk perception can be measured? We can predict people reaction under risk exposure?

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2. What is Risk and how it can be measured

Beck (1992) pointed out that humanity now faces such a wide variety of risks that it can be said that we live in a risky society. Thillson & Webster (2004) presented in one of their work the fact that in the academic literature, there is a great number of risk definitions. In this respect, researchers in different academic domains analyzed risk and defined it. As a result, a great variability it can be observed related with risk definitions. (table no.1)

Table no.1: The conceptual nature of risk - interdisciplinary and chronological approach

Definition	Author	Approaching perspective
Risk equals the product of probability and severity.	Crouch & Wilson, (1982)	Engineering
Risk is a dynamic concept based on causal interpretations, and thus initially exists only in terms of the (scientific or non-scientific) knowledge about it.	Beck (1992)	Sociology
The concept of risk refers to insuring oneself against possible loss, and the most accurate calculation of the costs and benefits involved.	Trimpop (1994)	Psychology
The potential to lose something of value. This loss may lead to harm that is physical.. .mental... social... or financial.	Priest & Gass, (1997)	Leadership
Risk is consumer's perception of the overall negativity of a course of action based upon an assessment of the possible negative outcomes and the likelihood that those outcomes will occur.	Mowen & Minor (1998)	Marketing
Risk is a function of profit and loss.	Elmiger & Kim (2003)	Investment
Risk can simply be defined as the probability that a harmful event will occur.	Weinstein, (2003)	Health
Risk is defined as a subjective construct influenced by how the event is interpreted.	Weber, (2004).	Psychology
A possibility of danger, harm or loss; and a chance of hazard.	Reisinger & Mavondo (2005)	Turism
Risk is related to the uncertainty that people discover in the conditions of a catastrophe, hazard, crisis, and this uncertainty determines the need for individuals, organizations, governments to take measures related to risk management……the assessment of risk perception at the individual level is personal, intuitive.	Blais et al (2006)	Psychology / Decision making
Risk is the probability of an event combined with the magnitude of losses and gains that it will entail. Risk is that which allows for a number of possible outcomes, and not all of which are bad.	Ganapathi & Vanitha, (2009)	Labor market
Some take risk as objectively given and determined by physical facts, whereas others see risk as a social construction that is independent of physical facts. These two views are scrutinized, and it is concluded that neither is tenable.	Hansson, (2010)	Risk management

Definition	Author	Approaching perspective
As the concept of 'risk' is a human construct, we cannot speak of 'real' or 'objective' risk as the concept of risk itself is of a subjective nature.	Rausand, (2011)	Management
In risk analysis, risk can be defined as a function of impact and probability.	Curtis & Carey, (2012)	Management
Risk is defined as the effect of uncertainty on an expected result, where: (1) an effect is a deviation from the expected – positive or negative, (2) risk is about what could happen and what the effect of this happening might be, (3) risk also considers how likely it is to take place.	ISO 9001: 2015	Risk management
Risk also evokes different emotional responses in different people and has different meanings to different people	Šotic & Rajic, (2015)	Psychology
Risk as the product of people's assessment of the severity and probability of negative outcomes.	Slovic, (2016)	Psychology
Risk should be defined as the *sum* of negative outcomes and the probability of their occurrence.	Le & Arcodia, (2018)	Hospitallity
Risk is the subjective understanding of outcome severity weighted by outcome probability.	Wolff et.al. (2019)	Health
The probability that an event will occur e.g. that an individual will become ill or die within a stated period of time or age.	HealthKnowledge, (2020)	Health

As it can be noticed the risk concept was studied and defined within the light of many disciplines and approaches, and each of these comes with different characteristics and models of measurements. Still there are some transdisciplinary aspects that can be underlined: (1) the probability of exposure / negative outcomes / occurrence / possible loss / become ill or die, and the, and (2) consequences of the effective exposure (what happened if…..).

Researchers presented risk perception as a constriction of the two components, considering the sum or product of these, but also as the subjective understanding of outcome severity weighted by outcome probability. According to Duțu (2020) risk perception is the interpretation that an individual makes with a view to the chances to be exposed to risk content, the assessment of risk content and the capacity to control the exposure. In this respect, for instance, perception over Covid infection is an interpretation of the extent to which the individual considers himself liable to be infected, the estimated outcomes of this situation and the control degree over infection. This interpretation is generating fear of Covid Infection and different emotions such as anxiety, depression, stress, fury, fear etc.. The highest values of this perception the highest behavior shifts. Thus, each risk is perceived and decoded differently by each and every individual, which is the assessment of the situational context, controllability of estimated effects, and confidence in these estimations (Sitkin and Weingart, 1995). Also, Wolff et al. (2019) pointed out that people, when assessing risk, largely ignore the probability of risk and that perceived risk should be measured not only as perceived probability but through the direct answer to the question of risk or danger.

Regarding risk measurement (Lee, 2020; Pandelica and Pandelica, 2011; Quintal et al., 2010; Ritchie et al., 2017; Dinh et al., 2020; Altarawneh et al., 2020; 2018) there is a certain

differentiation between fields of research. In some areas the measurement of risk is based on the cognitive side, based on mathematical calculation, other areas are based on the subjective side using scales for measuring emotions. In some studies there were also measurements focused on emotions, on the evaluation of feelings such as anxiety, anger, etc. (Fuchs et al., 2013; Reichel et al. 2007). The great diversity of the conceptual definitions of perceived risk, determines a great variety in concept operationalization and measurement Wolff (2019) stated that it should be assessed participants concerns (Reichel et al., 2007), others assess participants' fears (Fuchs, Uriely, Reichel, & Maoz, 2013) or feelings of nervousness (Sönmez and Graefe, 1998b). Some measure the perceived probability of events (Kozak, Crotts, & Law, 2007; Ritchie, Chien, & Sharifpour, 2017), while others question their risk (Wolff & Larsen, 2016a, 2016b). Others still do not report in detail how the perceived risk was measured (Lepp & Gibson, 2003; Reisinger & Mavondo, 2005).

3. Model of Risk Measurement

Certainly, not all individuals are alike and they do not react identically in a risk-generating situation as COVID-19 pandemic, because their risk perceptions are varying on a great extent function of: the estimation of the chances to be exposed to risk content (probability), the assessment of risk content (estimated consequences impact) and the perception regarding the own capacity to control the exposure (risk avoidance). Risk attitude is influenced by the three components of risk perception and the two internal psychological factors (risk perception and risk attitude) of the individual behavior vary on a certain scale from one individual to another. Thus, we can expect that individual behavior in order to manage the uncertain (resilience) to have different intensity and follow different patterns.

In the present study, we decomposed the perception of risk into three formative factors - the individual perception over the probability of risk exposure, the individual perception of the impact of the exposure (consequences severity) on the individual / household, the individual perception over exposure control (avoidance). Thus, in our measurement model we introduced the Risk Perception Index (RPI). RPI is a composite index, being the average of the Probability, Consequences and Controllability.

$$RPI = \frac{\textbf{Probability + Consequences + Controllability}}{3}$$

In the nowadays context of the COVID crisis, we expect the three factors that form the risk perception to determine the risk attitude and to have a causal relationship with the behavior shift reflected by the resilience strategies adopted at the individual level.

4. Research Methodology

A quantitative research was conducted on a sample of 712 Romanians, aged between 18 and 72, being residents of 22 counties from a total of 45 in Romania. The data collection was carried out between April 24 and May 9, during which the state of emergency was declared on the Romanian territory, starting with March 16, 2020. Empirical data was gathered on the national level, using the PsyToolsKit platform (Stoet, 2010, 2017), thus, the sample was constructed virally. 901 questionnaires were collected in the platform, out of which 712 were considered valid and introduced in the statistical analysis (79%). The validity of the scale was insured by the extensive analysis of research conducted in various fields such as economics, psychology, and sociology in order to assess the different aspects related to crisis, risk and uncertainty, as well as individual behavior in the crisis context and under uncertainty. In order to evaluate the internal consistency of the developed scale, the Cronbach’s alpha indicator

was determined. The Cronbach's alpha assessed was 0.753, greater than the acceptable standard value of 0.70. In order to develop risk map in the context of the COVID-19 pandemic, K-Mean Cluster Analysis was used. In order to develop risk map in the context of the COVID-19 pandemic, K-Mean Cluster Analysis was used.

5. Risk Mapping in Romania, 2020

For clusters construction purpose the three factors from the model were used - Probability, Consequences and Controllability. The resulting clusters represent patterns through which risk is perceived differently. RPI was calculated for each Cluster. The number of initial clusters (settled according to the conceptual model of psychological segmentation of the market) was 3. The initial centroids of the clusters were a random choice made by SPSS after which within each reiteration the grouping of the cases was made according to the closest Euclidian distances to the centroid of the recalculated clusters. Practically, within this algorithm, one focuses on the minimization of the variation inside the cluster and the maximization of the differences between the clusters. The results did not lead to significant differences between clusters. Thus, the process was resumed for 4 clusters. After nine reiterations, the final convergent value was reached. The minimum distance between initial centers was 4.472.

Table no. 2: The centroids of the final clusters of risk perception

	Cluster			
	1	2	3	4
Covid Infection Probability	2.14	1.52	3.57	3.84
Covid Infection Consequences	4.33	2.39	3.00	4.40
Controllability over Infection exposure	4.10	3.89	3.54	2.80

For each cluster, the risk perception index (RPI) was calculated according to the model and the mean value of Covid infection aversion was determined using Case Summarize, the results being presented in table no. 3.

Table no. 3: RPI and RA assessed at cluster level

	Cluster			
	1	2	3	4
Risk Perception Index (RPI).	3,55	2,60	3,37	3,68
Risk Aversion	3.86	2.70	3.42	4.05
% of Total N	22.3%	25%	34%	18.7%

Cluster profiling

Cluster no.1. - is composed by individuals who have a relatively high perception of Covid infection and dislike this situation to a relatively high extent.

Cluster no.2 - the members of this segment have a low perception index of the risk perception over Covid infection and, at the same time, they feel relatively comfortable with this risk having a relatively low level of aversion over Covid infection.

Cluster no.3. - although it is quite close in profile to cluster 1, it tends to be relatively more homogeneous in terms of the two dimensions - RPI and RA - which have very close average values.

Cluster no.4 - this segment has the highest value of RPI but also of RA. Thus, individuals in this segment have the highest perception of the infection risk and feel the greatest discomfort with this situation, greatly displeasing the prospect of COVID-19 infection.

Figure no.1: Risk mapping in Romania, April 2020: Pandemic context

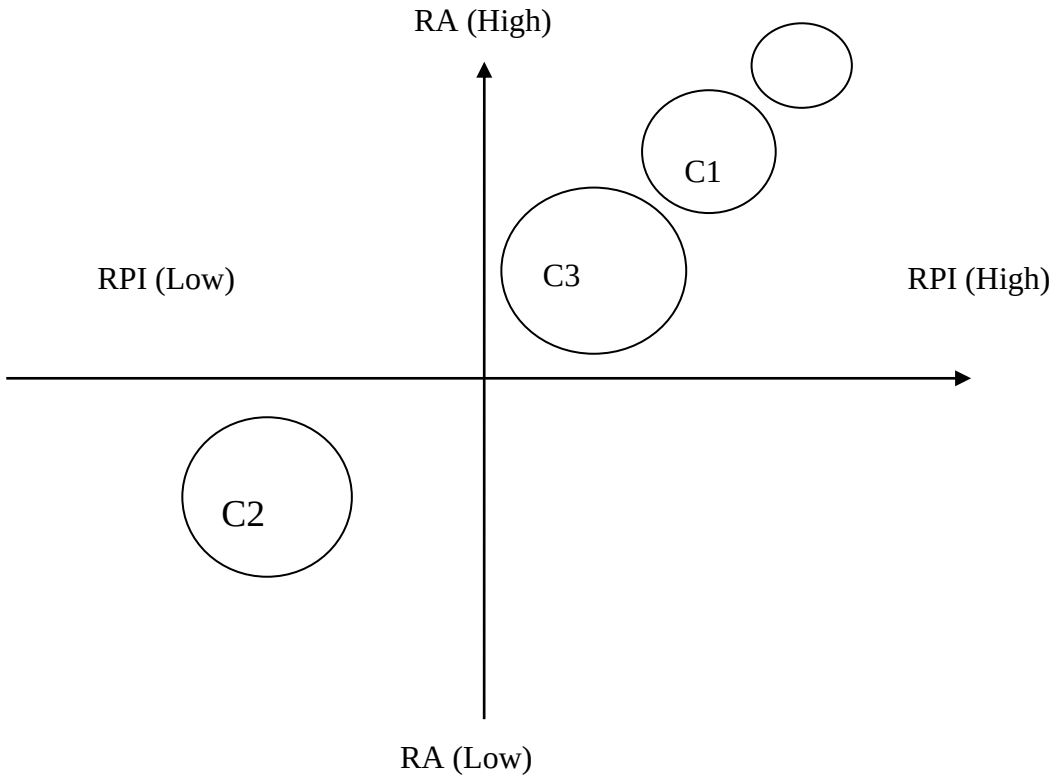

Table no. 4: Strategies for crisis management - the health perspective

	Cluster			
	1	2	3	4
Wear a mask and gloves	4.1258	3.2360	3.9174	4.3534
Keeping the social distance	4.1384	3.6180	4.0041	4.3684
Compliance with the rules imposed by the authorities	3.8365	3.1685	3.5413	3.6039

As can be seen, the most intense application of strategies for health protection is found in the segments that have the highest level of risk aversion, but also the highest value of RPI. In the case of Cluster 2, where a low value of RA and RPI was identified, the applied strategies have a much lower intensity.

Variation of RIP and RA according to indirect and direct risk exposure

Those who have been exposed, directly or indirectly, to risks (Covid infection in the family, friends, job loss; technical unemployment, etc.) have a higher level of perception about the probability of risk exposure, perception on the severity of the effects of exposure, but also a higher level of risk aversion. Thus, comparing the averages of those who have in their close relatives (relatives, friends) a person infected with COVID with those who do not know a COVID infected, it is observed that they appreciate more that it is possible to become infected and consider that they will be affected more severely than perceived those who do not know a COVID-infected person. They also appreciate to a lesser extent that they can control COVID infection through their own behavior, compared to those who do not know a COVID patient directly.

Table no. 5: Variation of RIP and RA – indirect exposed vs. not exposed

Report					
the extent to which the respondents have in the close circle infected with Covid		Probability of Covind infection	Consequences of infection exposure	Aversion over Covid infection	Controllability over Covid infection exposure
Yes	Mean	**3.1071**	**3.6429**	**3.5357**	**3.0714**
	Std. Deviation	1.28638	1.02611	1.17006	1.05158
No	Mean	**2.7778**	**3.3962**	**3.4561**	**3.6389**
	Std. Deviation	1.15948	1.02504	1.12712	.87407
Total	Mean	**2.7907**	**3.4059**	**3.4593**	**3.6166**
	Std. Deviation	1.16550	1.02548	1.12810	.88774

Analyzing the same aspect, from an economic point of view, we compared the means of those who were affected by unemployment with the averages of those who were not affected by unemployment. Also, in this case the RAP and RA are varying along with category – direct exposed vs. not exposed.

Table no. 6: Variation of RIP and RA – direct exposed vs. not exposed

Report					
the extent to which the respondents have been exposed to unemployment		Probability of job loss	Consequences of job loss	Aversion over job loss	Controllability over job loss
No	Mean	**2.8741**	**4.1066**	**3.1115**	**2.4092**
	Std. Deviation	1.24902	.99854	1.14782	.78760
Yes	Mean	**4.2308**	**4.6667**	**4.2727**	**1.5385**
	Std. Deviation	1.09193	.65134	.90453	.66023
Total	Mean	**2.8989**	**4.1177**	**3.1327**	**2.3933**
	Std. Deviation	1.25885	.99554	1.15378	.79369

6. Conclusions

The present study had the purpose to introduce a new model for assessing the individual risk perception, presented as Risk Perception Index (RPI). RPI is a composite index, being the average of the Probability, Consequences and Controllability.

Also, the study introduces a risk mapping in Romania that was constructed using Risk Perception Index (RPI) and Risk aversion (RA).

The results of the study suggest that in crisis contexts, the psychological market segmentation will be more effective than a psychographic one. Thus, this results can be use in order to frame the business strategies in the context of this crisis, but also in other type of crisis. On the other hand, at the governmental level, in order to frame the communication strategies for crisis management, these instruments can be used.

Some interesting findings sustained that those who were directly exposed to risk tend to have a higher value of RPI and RA, but also those who were indirectly exposed (know someone close who was exposed). Also these categories tend to have a high shift of behavior.

The limits of that study come from the fact that the empirical data reflects only one faze of the crisis. Certainly, there is a dynamic of RPI and RA according to crisis cycles – the beginning of crisis, the worsening of crisis, crisis stabilization, the recovery etc. Also, we expect to have a certain dynamic according to the crisis curve – W, V, U. For instance we expect to have a certain dynamic form one wave to another of the Covid pandemic.

7. References

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