

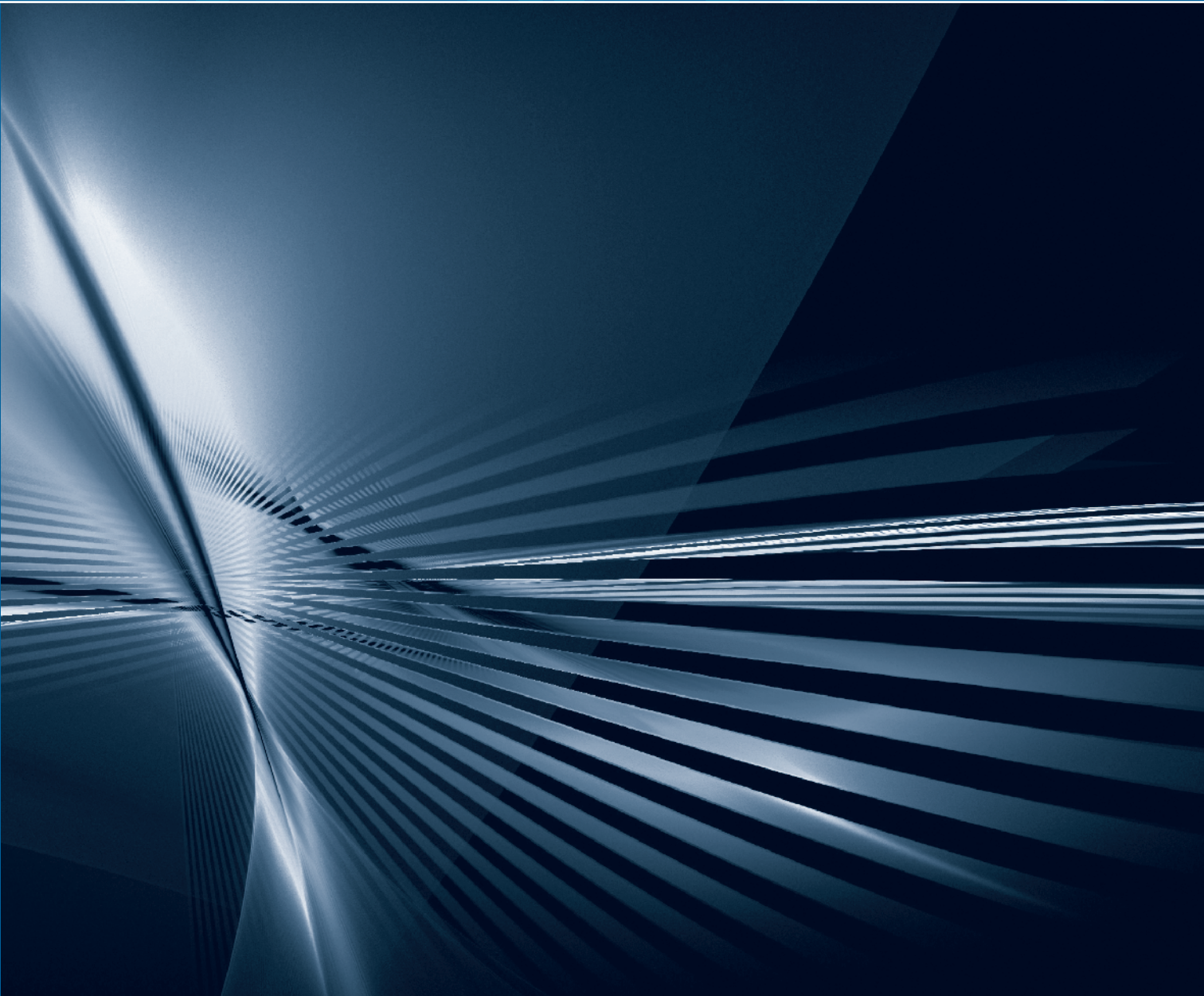
# ORGANIZACIJA

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# The Indifferent, the Good Samaritan, the Brave and the Agent in Allais Paradox situation – or How Endowment Effect Influences Our Decision in Case of Allais Paradox?

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*“The real substance on which the economist works remains economic and social.”  
(Allais, 1988)*

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**Background and purpose:** Mainstream economic models do not take ownership into consideration. Only after the findings of behavioural economists was endowment effect widely observed. Endowment effect means that goods that one owns are valued higher than other goods not held in endowment. At the same time the principal-agent literature is concerned with how the principal (such as employer) can motivate his agent (say the employee), to act in the principal's interests and also for their holdings. The main problem is that acting in somebody's else's interests can influence our values as well. Moreover, the principal as owner suffers from endowment effect. Both situations can be treated as a risky decision. Risk confuses our rationality in a predictable way.

**Design/Methodology/Approach:** Due to this it was observed how foreign students from various cultural backgrounds decided (n=186 answers) in a risky financial situation by focusing on Allais' classic gambles. I also presented their preferences over certain and uncertain outcomes regarding the owner of the final win; i.e. how they choose for themselves or on behalf of one of their best friends. One famous experiment - which tested the descriptive validity of the axioms' expected utility theory - was Allais. Allais handled probabilities and outcomes in high hypothetical payoff financial gamble situations; he found that when offering two similar options, the common consequences will not be removed by the actors. I was interested in what happens when the actors take risks on behalf of others. It was used between-subjects technique on an extended multicultural sample. Regarding the two different topics, three hypotheses were tested (1); based on Allais paradox (2); observed ownerships (3); the comparison of two phenomena.

**Results:** The results show that the subjects responded differently when they needed to decide about their own properties rather when their friends' properties were concerned. When a sure safe outcome was offered to the subjects, they took more risk on behalf of their friends rather than own. Moreover, the subjects do not take into consideration that the same attributes must be ignored, so Allais paradox was verified.

**Conclusion:** The goal of this paper is then twofold. First, it was established a conceptual link between Allais-type behaviour and ownership problem. Second, Allais axiom was used to characterize different roles. Knowing predictable patterns of seemingly irrational heuristics in human behaviour can improve economic theory. At the same time, this knowledge helps us to avoid irrational decisions.

**Keywords:** Allais paradox; Endowment effect; Principal-Agent Problem; Risk

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## 1 Introduction

Nowadays, it is well-known that an average employee spends more than 25 percent of their working life deciding on others' interests. Despite the fact they take risks on behalf of others, i.e., are responsible for others' utilities maximizations, they try to do their best. They allocate scarce resources to satisfy others' wants and needs.

At the same time, not only economic resources are scarce, in addition, human psychological resources - like attention - are limited as well. Due to this, the profit-maximizations of the aforementioned employees are not accomplished; this is, in a part, because of the lack of complete information. In decision-making, the Nobel Prize winner Herbert Simon (1971) believed that agents face uncertainty about the future and costs in acquiring information in the present. These factors limit the extent to which agents can make a fully rational decision, thus they possess only "bounded rationality" and must make decisions by "satisficing," or choosing that which might not be optimal but which will make them or the owners happy enough. So they will use special heuristics (rules of thumbs based on previous experiences) which hurt the rationality of 'homo oeconomicus model act'. These two issues provide the importance and relevance of this experiment.

### 1.1 Theoretical background

#### 1.1.2 Expected utility theory

Choosing rationally is equal to choosing the option with the higher expected utility (EU), defined as  $EU = \sum u(x_i) p_i$  where  $p_i$  and  $x_i$  mean the probability and the amount of payoffs,  $u$  is the function of the payment, respectively, associated with each possible outcome ( $i=1, \dots, n$ ) of that option. Later, von Neumann & Morgenstern (1947) explained expected-utility theory on axiomatic grounds; it quickly became the most influential theory of individual choice behaviour. (Hertwig et al. 2004). Assumptions of the expected utility theory were laid in the 1940s by Neumann and Morgenstern. They offered several simple axioms, characterizing preferences of rational actor, they suggested that the utility of a risky gamble should be the probability weighted average of the utilities of its possible outcomes (Camerer, 1998).

One of these axioms are the so called independence implies. The independence axiom shows how choice is influenced by only the differences among many alternatives, but the same attributes must be ignored. It means that, when comparing gambles, all common outcomes that have the same probabilities will be handled by the subjects as irrelevant. One famous experiment which tested the descriptive validity of the axioms of expected utility theory were the Allais' experiments. He found that under certain conditions subjects would violate this aforementioned in-

dependence axiom. (Oliver, 2003). The Allais paradoxes were enough to cast some problem on Neumann and Morgenstern's theory.

As Hertwig et al. (2004) summarized "Perhaps the most prominent violation is the Allais paradox (...) in which decision makers choosing between risky prospects do not conform to the independence axiom, according to which outcomes common to all prospects (and with known probabilities) should have no influence on the decision." (p. 535)

The empirical testing, experimental methods became the focus of decision making. Because various studies began to propose ways to generalized Allais paradox to explain data. During this period, most scholars were tested by psychologists and covered on the interdisciplinary area between psychology and economics. Important work includes weighted utility theory, rank-dependent theory and finally the famous prospect theory (Kahneman & Tversky, 1974). Most papers included an obligatory discussion of how their theories could explain the Allais paradox. There were a couple of datasets without clear conclusion, but the experimental methods served as models for researches. Camerer (1998) summarized some periods after Allais' finding. Only few of them are mentioned here, because those serve like limitations of the original Allais' problem and either this research. Some researchers have focused on fitting theories to personal characteristics (see later Palmer et al. 2013), and risk taking can be one of these characteristics. Estimation of uncertainty and probabilities are subjective (personal). In addition, they are revealed by choices. One's decisions are influenced by their earliest experiences; so-called subjective expected utility theories provided new experiments like Ellsberg "two color problem". Most experiments require people to weigh current problems against future outcomes, but those problems are relatively new and not likely or known by the subjects. Due to this, it seems that knowing how preferences are formed over time is also needed. Finally, it is important to understand the environment, and cultural background. Aforementioned findings brought new theories but importance of Allais paradox does not disappear.

#### 1.1.2 Allais paradox

Allais used a standard gamble situation with money (financial) outcomes. The common consequence effect tested empirically how the subjects' choices violated independence. Allais argued that when the individuals are faced with the situations detailed in Table 1, they changed their preferences. Because, when we ignore common outcomes or consequences (i.e. outcomes with 0.89 probabilities), the outcome of Gamble A (in Case X) is equal to outcome of Gamble C (in Case Y); at the same time, Gamble B is equal to Gamble D. Despite of this most of the subjects chose Gamble A in Case X and Gamble D in Case Y. This

Allais Paradox was tested between subjects (they were divided into two groups related to the cases, and only one case was offered) and within subjects (i.e. both cases were offered for each subject) methods, as well. Here, I used the between subjects technique.

The suggested amount of outcomes serves as a reference points for the actors. Huck & Müller (2012) implemented three different treatments; one with the original version (high hypothetical payoffs); another with low hypothetical payoffs; and the last one with low but real payoffs. According to the authors, violations were systematic and significant, but much lower when outcomes (stakes) are low; also, these were much lower in a laboratory environment than on real fields. I agree with the authors who suggested that it would be more useful to study relative real outcomes rather than hypothetical absolute levels. Maybe changing the topic of the outcomes might solve this problem. However, Oliver (2003) tested it using health outcomes. He also verified Allais' paradox in his empirical testing (he used health outcomes with the classic probabilities). He found that this effect was stronger when the participants also gave extended possibilities to provide explanations. I agree with Khalil (2015), who provided a relatively new reason for Allais problem and connected Allais paradox with shoplifting. He wrote, "Regretting a rational decision means changing your belief about that decision so that what appeared optimal at the time now appears suboptimal. Concerning the Allais paradox (the certainty effect), it is the outcome of people's fear of regret. Fear of regret leads people to become over-cautious, using biased under-confident beliefs that lead them to compulsive behavior such as seeking zero-risk options." (Khalil, 2015, p. 551).

As a result, Huck & Müller (2012) found significant differences between demographical characteristics of actors; consequently, the undergraduate persons with lower incomes were less consistent. Da Silva et al. (2013) asked

120 students biological and demographical background before testing Allais paradox. I think their small number and widely heterogenous sample does not cover the needed statistical pre-requirements. However, the authors found "that women, in particular if not menstruating, are more "rational" in that they are less susceptible to the Allais paradox. Those born to not-too-young mothers are more rational, too. Those who father kids are also more rational. Those with high prenatal testosterone exposure are more rational. Those with many negative life events are also more rational. Anxious, excited, alerted, happy, active, and fresh people are also more rational. Left-handers and atheists are possibly more rational, too." (Da Silva et al., 2013, p. 568). In my case, the limited size and non-representative sample did not allow testing deeper gender differences or family background, moreover, I did not focused in female respondents' menstrual cycle or answerers' mother's age, parenthood or digit ratio as Da Silva et al. (2013) did.

Van de Kuilen and Wakker (2006) tested empirically how Allais paradox works if subjects are given the opportunity to learn by both thought and experience. They argued that in both cases the number of expected utility violations decreased significantly because learning can reduce probability transformations. With reputation and feedback, subjects learned and avoided violations of expected utilities. In this experiment, no learning possibilities or feedback were given to the respondents. It used one of the typical lab online methods but did not control the influences of the environment. Only the number of decisions / choices were calculated quantitatively and there were no measurement of how aware people are of the decisions they make and how the environment influences these decisions.

It can be realized that if the common consequences (i.e. highlighted column in Figure 1) are removed Case X is equal to Case Y. However, if we consider all probabilities, it can also be realized that Case X is not risky because it contains a safe option with a sure outcome (Gamble A).

Table 1: Allais' paradox, where independences are highlighted (Own source)

			Probabilities			
Case X	winnings	probability	0,1	<b>0,89</b>	0,01	Wining
Gamble A	100	1	100	<b>100</b>	100	
Gamble B	100	0,89	500	<b>100</b>	0	
	500	0,1				
	0	0,01				
Case Y	winnings	probability	0,1	<b>0,89</b>	0,01	Wining
Gamble C	100	0,11	100	<b>0</b>	100	
	0	0,89	500	<b>0</b>	0	
Gamble D	500	0,1				
	0	0,9				

Table 1, which is based on the classic, original Allais experiment, was experimentally verified in this paper (detailed in chapter 2).

Wu & Gonzalez (1998) categorized the different types of Allais paradoxes; they described three common consequence effect conditions: horizontal, vertical, and diagonal shifts within the probability triangle. The first two conditions are shifts in probability mass from the lowest to middle outcomes and middle to highest outcomes, and the third proposed weighting functions. That means individuals violate the independence axiom for small as well as large outcomes, for real as well as hypothetical payoffs, and for small as well as large probabilities, as a result the original expected utility theory is not able to explain choices under risk. They suggested that cumulative prospect theory (CPT) of Kahneman and Tversky can describe all three conditions. Later, Birnbaum (2007) gave an extended and deeply detailed mathematical interpretation of various Allais paradoxes. He suggested a new descriptive model, the transfer of attention exchange model (TAX) and compared it with aforementioned subjectively weighted utility theory (SWU) (Camerer, 1998) and lower gains decomposition utility model (LGDU). He used informational asymmetrical problems (e.g. sellers and buyers in negotiation or bargaining) and represented endowment effects in Allais situations.

This paper will not compare various models of Allais paradoxes. However, Birnbaum's finding (2007) is a possible improvement for this paper. In spite of mathematical terms helping us to underpin common consequences, (probabilities and outcomes are turned into equation), to tell the truth, I absolutely agree with Allais: "The use of even most sophisticated forms of mathematics can never be considered as a guarantee of quality." (Allais, 1988). As a result, in this paper, the original descriptive model was tested empirically with two different owners' positions. It used the classic model of preferences using high payoffs with certain and uncertain outcomes offered to owners or on behalf of another. I applied a static instead of a dynamic model, because according to Andreoni & Sprenger (2010), risk preferences are not time preferences.

In the classic experiments, no property problems were taken into account, but I was interested in any connections between predictable, seemingly irrational heuristics. The following chapter discusses and details the problem of properties.

### 1.1.3 Ownership

Although actors usually take risks, where the target of the purchases or capital belongs to other actors, i.e. the previous actors, they make decisions about someone else's interests. The relationship of agency is one of the commonest modes of business interactions. However, mainstream economic models do not handle endowment effect or the

problem of interests.

Only after the findings of Thaler (1980), was endowment effect widely observed. Endowment effect means that goods one owns are valued higher than other goods not held in endowment. This effect is mostly interpreted (like in the previous chapter) as the result of loss aversion (Kahneman & Tversky 1979). It seems Kahneman and Tversky work is universal model for both problems. Actors value losses (negatively framed outcome of a risky situation) higher than gains (outcome above the reference point) during the evaluation of choice options. Moreover, if somebody owns a product, the prospect of losing or selling is equal to losses. Dupont & Lee (2002) tested this wedge, they verified Thaler's findings and they highlighted that the majority of the people questioned in surveys failed to give a price that would compensate them for taking on more risk.

Interestingly, the ownership itself can refer not only to objects. Zoltay Paprika & Nagy (2012) found that, e.g., the ownership structure of companies played an important role when they examined how creativity was assessed on the job market. Since it was divided into the following categories - Hungarian, foreign and mixed ownership - based on a similar approach, it could be worth examining the endowment effect in international dimensions as well.

Originally, the endowment effect is robust and well-documented in results of experimental economics. This effect introduces a huge gap between the prices at which one is willing to sell or buy a good owned by them. This discrepancy between the maximum willingness to pay for a good and the minimum compensation demanded to part from the good causes a principal agent hierarchical situation.

Moreover, the question is given: What about those who do not own any items but behave as an owner might? The first author who studied this field was Arrow (Arrow, 1984). Based on his theory, Ross (1973) gave a widely mathematical explanation about agency problem. The principal-agent literature is concerned with how the principal (owner) can motivate his/her agent (non-owner) to act in the principal's interests: therefore the principal cannot observe the actions themselves. The agents must choose an action from a number of alternative possibilities (in my research only two possibilities were offered). As Arrow (1984) suggested, the outcome (possibility) is affected - but not completely determined - by the agent's behaviour. Both principal and agent are assumed to be making decisions optionally in view of their own needs. In sum, the agents will play either fair or not fair. Although in this paper principal - agent theory was referred, here can be found a simple hypothetical decision change. My approach, however, differs from that of Arrow (1984) in several ways. The original situation is more complicated. Bakacsi (2015) summarized the characteristics of principal - agent problem which are the following: (1) both the



agent and the principal manage and control a stock that is important and represents a special surplus for them; (2) the principal owns and control resources and the agent adds value; (3) they have different aims both are selfish and rational that leads to so called opportunistic behaviour; (4) participants made a previous contract based on the bargaining power of the agent but; (5) the agent plays fair or not fair (i.e. he/she is opportunistic). The principal is able to control this problem in three different ways with use of (a) controlling system, (b) motivation and (c) fixed behaviour norms. According to him, this situation is a simple behaviour-economical, decision theory paradigm, where the actors are peers. Reb & Connolly (2007) underlined that the subjective ownership by independently manipulating factual ownership (i.e., what participants were told about ownership) and physical possession of an object influence each other. Their results showed that the endowment effect might be primarily driven by subjective feelings of ownership rather than by factual ownership. In other words, it the development of a subjective sense of endowment and possession lead actors better, rather than a legal entitlement. Due to this, friendship can serve as a perfect example for subjective sense of endowment. Moreover, Chang et al. (2016) found interactions between altruist and egoist depending on individual heterogeneity. They found that actors (the givers) became more altruistic and willing to help if they know the other subject (the receivers).

Falk et al. (2008) underlined that fair-minded persons are likely to have important economic effects based on their fairness. Because of these issues, it is advantageous to group any agents' behaviour. Hámori (2003) differentiated various types of altruism, here reciprocal altruism was assumed because friendship, businessman' agreement, partnership are typical examples of reciprocal altruism. Small & Loewenstein (2003) investigated

laboratory studies, they maintain that many decisions are driven by arguments or reasons, rather than value-based calculations of options, and friendship is a pretty important reason. They found that determined victims received more money; that means when the victims were determined the subjects donated more money.

Regarding the theories, this paper's groups (roles) are the following:

- *Indifferentists or Same safe choices*: are those who do not take risk for themselves nor on behalf of a friend. They select the same safe choices two times, i.e. in both cases.
- *Good friends*: are those who play risky for themselves but avoid risk in place of a good friend (protect their gains).
- *The braves or Risk-Takers*: are those who take risk in both situations (they are not influenced by the identity of the owner.)
- *Agents against principal*: avoid risk when they have to decide about their money but they take risk on behalf of their friends.

Table 2 helps us to clarify each groups.

This problem was tested earlier (see Kolnhofer-Derecskei, (2017) - this paper dealt only with the endowment problems, Allais paradox was skipped). Linking Table 1 and Table 2, I was able to measure the connection between endowment effects and Allais paradox.

Conceptual model of this research is presented in Figure 1. The two topics provide two separated hypotheses (H1; H2); a third hypothesis (H3), can be connected and compared to the previous two.

Table 2: Survey variations (Own source)

Owner Situation	Self		Good friend	
	Certain	Uncertain	Certain	Uncertain
Same safe choices INDIFFERENTIST	X		X	
Good friends FRIEND		X	X	
Risk taker BRAVE		X		X
Principal agent AGENT	X			X

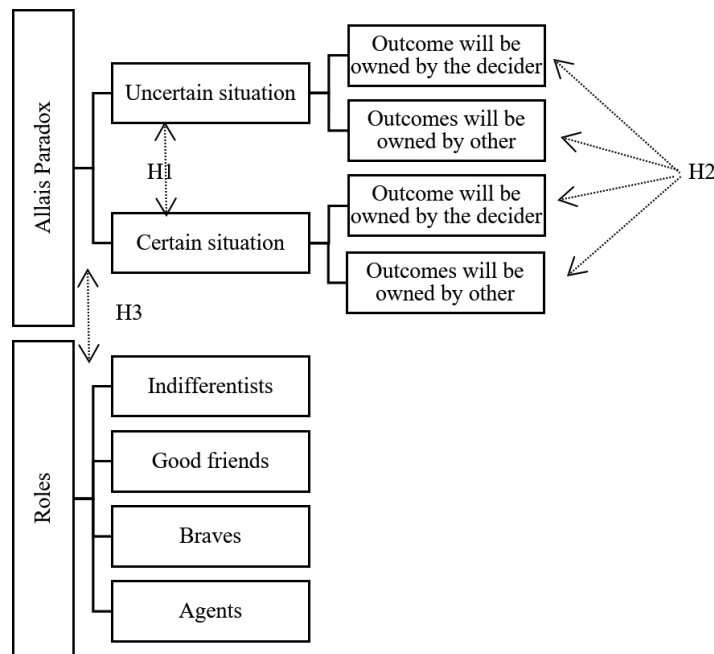


Figure 1: Conceptual model based on theoretical background (Own source)

## 2 Methods

### 2.3 Research questions and hypotheses

Separating the two aforementioned behavioural economics' heuristics allowed the following hypotheses to be tested:

*H1.* Allais paradox will be interpreted in both cases. There will not be any differences according to who controls the hypothetical outcomes (i.e. the subjects need to decide for themselves or on behalf of their good friend).

*H2.* The subjects will respond differently when they need to decide about their own interests rather when their friends' interests are concerned. The actors can be identified by the aforementioned types, see Table 2.

Linking together both above detailed topics, finally the following hypothesis was observed:

*H3.* When a sure, safe outcome with 1.0 probability is offered to the subjects they take more risk on behalf of their friends and protect their own chances; i.e., they will not be a risk taker on their own behalf (here Allais variant A) by comparison with the other Gamble (here Allais variant B).

Due to the sample selection mainly robust (non-sensitive) non parametric test (with significance level 0.05) and symmetric measures were used with SPSS 22.

### 2.4 Methods

The original version was implemented with high hypothetical payoffs. It was used between subjects form; that means the respondents were divided into two groups based on their birthdates. Charness et al. (2012, p. 1) defined this technique as the following "In a "between-subject" designed experiment, each individual is exposed to only one treatment. With these types of designs, as long as group assignment is random, causal estimates are obtained by comparing the behavior of those in one experimental condition with the behavior of those in another." They suggested that this design is more likely and preferred in field of social sciences than within-subject design. In this research, the sample was divided into two different groups. this design provides half the amount of information given the sample size but as Charness et al. (2012, p. 8) suggested, "Between analyses are statistically simple to perform as long as random assignment is achieved across groups". In contrast, Birnbaum (2008) advised a different assessment method. According to him, a large number of replications with a large number of properties tested within the same person can only help to analyse personal differences.

On the other hand, Allais followed the between subjects methodology with no replications nor feedback. In this case, one group with even birthdates got the first Allais's gamble (variant A) which also contains a safe sure outcome. The other one (odd birthdates) received the other Allais's gamble version (variant B). Both offers can be seen in Figure 2 and detailed in the aforementioned Table 1. The

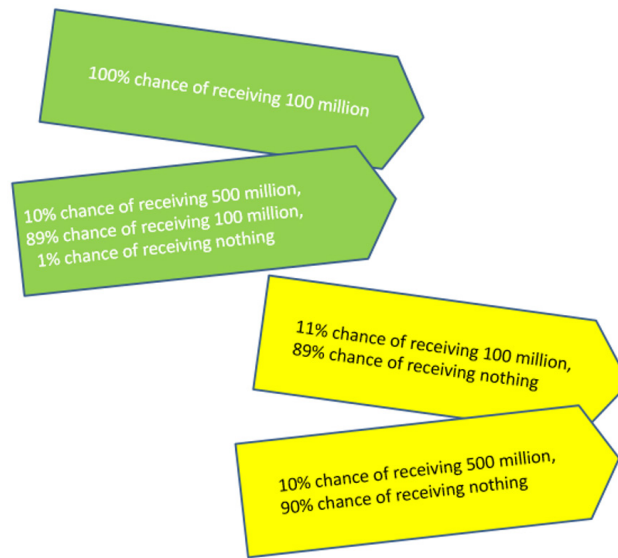


Figure 2: Allais' gambles (Own source)

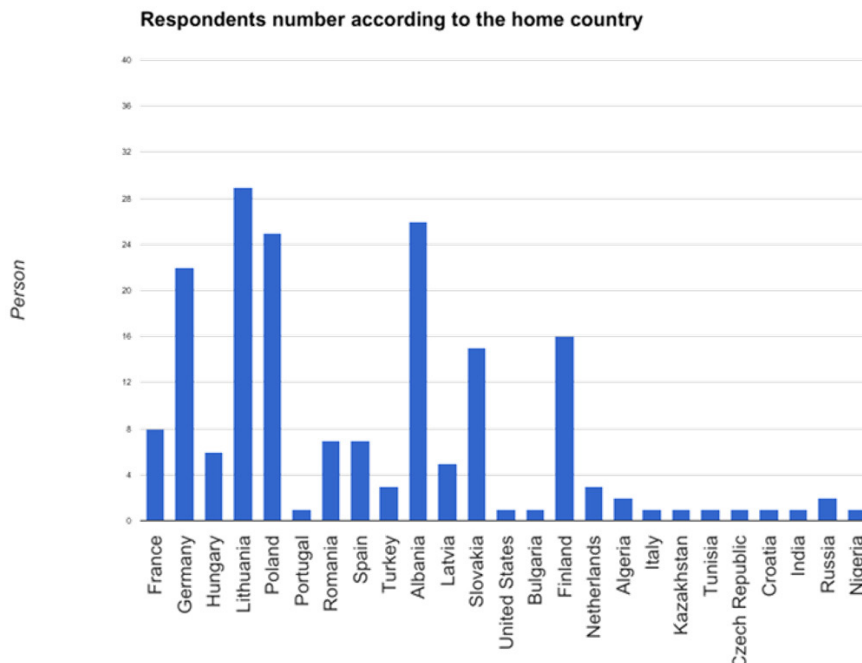


Figure 3: Sample statistics regarding ethnicity (capita) (Own source)

experiment was a between-subjects survey (two groups) and the classic version with high hypothetical payoffs was used. It took place online (so called lab experiment situation). No feedback or reputation possibilities were given to the subjects.

This experiment was only a part of a wider research. A pilot version was tested and evaluated earlier (see Kol-

nhofer-Derecskei (2017)) and the original text can be found in the Appendix. The survey (i.e. Google Form) was shared electronically among the partner universities of Obuda University Keleti Faculty of Business and Management; original, whole texts of the questionnaire can be reached on the Internet<sup>1</sup>.

<sup>1</sup> Link to survey is: <https://goo.gl/forms/AY2OIMFstUZ6KnRe2>

## 2.5 Sample

After clearing and clarifying data, the evaluated number of answers is 186. As mentioned earlier, my chosen population (target group) was university students studying at any partner university (see Figure 1). It is a fact that current university students will be future employees, and higher education institutions are facing serious challenges all over Europe. As well as the high rate of unemployment, lack of professionals, the decrease in the number of younger generations, the expected quality and content of knowledge has also changed. Therefore, we need to know their behaviour (Kádár-Reicher 2016).

However, the sample was multicultural (different ethnicities) but the subsamples' sizes do not allow concentration on national comparisons.

The subjects were divided into two groups according to the date of birth (even number variant A contains 89 persons, odd number variant B has 97 persons). The minimum age of respondents was 19 years old, the maximum 57 years, and an average of 24.51 years of age. There were 80 males and 106 females. Overwhelmingly, respondents were studying business (n=124) or engineering (n=52); 10 persons were from other faculties. Study levels are the following: 121 persons attend bachelor full-study programs; 60 persons master studies and there were five doctoral students.

## 2.6 Hypotheses testing

In this chapter, any hypotheses are being tested step by step.

*H1.* Allais paradox will be interpreted in both cases. There will not be any differences according to those who modelled the hypothetical outcomes (i.e. the subjects need to decide for themselves or on behalf of their good friend).

Comparing both gamble variations, there were no significant differences between them regarding the ownership. As a result, almost the same distribution can be seen in Table 3. Most of the subjects chose the first safe option in the first gamble and in the frame of the second variant they preferred the second one. That mirrors Allais' original findings. In both cases there was significant symmetrical measurement, but weak connections were found e.g. Cramer 0.223 ( $p=0.02$ ).

*H2.* The subjects respond differently when they need to decide about their own properties rather when their friends' properties are concerned. The actors can be divided related to the aforementioned types, see Table 2.

All the aforementioned roles (types of subjects) can be identified with the following frequencies (see Table 4). Around 70 percent of the subjects chose the same options for themselves and on behalf of their friends, half of them voted for the risky (certain) and another half for the uncertain (not risky) outcomes.

Relating to Huck & Müller (2012), I was interested in gender differences as well. Although there were no significant differences (using non-parametric Mann-Whitney test sig. level 0.05 Asym. sig  $p= 0.199$ ), the crosstabs analysis could be interesting because men (males) took risk more often (see Table 5). But Da Silva and colleagues findings cannot be verified.

*H3.* When a sure safe outcome is offered to the subjects they take more risk on behalf of their friends and protect their own win (i.e. they will not be risk taker on behalf of themselves, here Allais variant A) compared with the other gamble (here Allais variant B).

This hypothesis can be accepted as well, because in the A

Table 3: Frequencies of Allais (capita) (Own sources)

Allais A	Winnings	Probability	Number of respondents	
			Self	Good friend
Gamble A	100	1	61	61
Gamble B	100	0.89	28	52
	500	0.1		
	0	0.01		
Allais B	Winnings	Probability	Self	Good friend
Gamble C	100	0.11	45	43
	0	0.89		
Gamble D	500	0.1	52	54
	0	0.9		

Table 4: Crosstabs according roles (capita) (Own source)

Roles	Frequency	Percent (distribution)
Agent	23	12.4
Indifferent	74	39.8
Good friend	30	16.1
Risk taker	59	37.7
Total	186	100

Table 5: Crosstabs according gender and roles (capita) (Own source)

Roles	Gender		Total
	Male	Female	
Agent	7	16	23
Indifferent	32	42	74
Good friend	12	18	30
Risk taker	29	30	59
Total	80	106	186

Table 6: Crosstabs according roles and Gamble Variant (capita) (Own source)

Roles	Allais variant		Total
	A	B	
Agent	9	14	23
Indifferent	43	31	74
Good friend	18	12	30
Risk taker	19	40	59
Total	89	97	186

case (with sure outcome) most subjects ( $18+43=61$  person) voted for the certain outcome rather than in B (uncertain) gamble ( $n=12+31=43$ ). Other connections (e.g. relationships with level of studies or main subjects) were not confirmed.

### 3 Discussion

The goal of this paper is then twofold. First, it was established a conceptual link between Allais-type behaviour and ownership problem. Second, Allais axiom was used to characterize different roles. Since the original Allais experiment, several variations were tested, some of them are detailed above, and others are only mentioned.

Nonetheless, in this paper the subjects faced with the original Allais situation. This research investigated how the subjects behave in the same situation but on behalf of their friends, so the Allais paradox (widely heuristics) and ownership problem (widely endowment economy) were connected.

Earlier also Birnbaum's paper (2007) proposed endowment effect and Khalil (2015) dealt with principal and agent framework, as well. I agree with Khalil's explanation "The principal and the agent have identical preferences. They differ only with respect to their beliefs. The principal's beliefs are optimal in the sense of being the best given the information. The agent's beliefs are suboptimal; they are based on over-estimation of the likelihood of success. Consequently, the agent recommends to the individual impulsive (suboptimal) actions, while the principal recommends to the individual optimal decisions." (p. 558).

Because my results underlined it, summary of the results can be found in Table 7.

Finally yet importantly, we must ask what the reasons are for the Allais paradox also happening when the subjects take risk on behalf of somebody else. According to Oliver (2003), I summarized some possible explanations for Allais effect.

The first explanation is the classic Kahneman & Tversky's loss aversion effect (prospect theory). These Nobel



Table 7: Hypotheses testing (Own resources)

Hypotheses	Results
H1. Allais paradox was be interpreted in both cases.	Accepted
H2. The subjects responded differently when they needed to decide about their own properties rather when their friends' properties were concerned.	Accepted
H3. When a sure safe outcome was offered to the subjects, they took more risk on behalf of their friends rather than own.	Accepted

Prize-winning authors presented a critique of expected utility theory as a descriptive model of decision making under risk and developed an alternative model. According to their work, people tend to avoid risk when a positive frame is presented, but they seek risks if a negative frame is utilized. This effect may be strong in the choice between the two situations. The subjects have the possibility to avoid the possibility of winning nothing. The amount of money offered is quite high and serves as a reference point.

The second reason can be that when certainty is anticipated, disappointment may confuse the original expected utilities. This cognitive process applies to probabilities rather than the outcomes. My findings indicate that certain and uncertain consumption are evaluated differently; I found significant differences between risky (uncertain) and non-risky (certain) Allais variations. The perceived level of risk also influences our decision; making a decision under risk, where the possibility of losing our ownership is higher than the risk taken on behalf of our friend, makes us risk averse and confuses our preferences.

In this experiment, significant differences can be found between deciding for ourselves and deciding in place of a friend. My findings assume that people decide systematically in different ways about their own property rather than about others'. They are more risk averse when the outcome is theirs but will take risk on behalf of others. At the same time, this verifies the Agent- Principal Theory and the Endowment effect.

In the results, I need to underline that in the second situation the safe wins were more attractive for the subjects than the feeling of risk. Due to this, in variant B they focused more on the amount of safe winnings (i.e. USD) than the probability of win options (i.e. percentage). In the case of variant A, it was reversed.

#### 4 Limitations of the study

I agree with Huck & Müller (2012) that "it appears that lab results will draw a too optimistic picture. The population at large, it turns out, is less consistent with EUT than student samples are." (p. 276). Van de Kuilen & Wakker (2006) summarized the limitations of Allais paradox, as they said, "our study gives the first pure demonstration that irrationalities such as in the Allais paradox are less pronounced

than often thought" (p. 155). As it was underlined earlier, it is typical that the subjects had never faced these situations before, so their decisions could be based on simple misunderstandings or misinterpretations rather than on irrationalities. Thinking in probabilities is also unfamiliar for the subjects. Most of the experiments (like the present paper) use poor descriptions instead of any visually or numerically understandable overview. Hertwig et al. (2004) called this form 'decision from description'. They proposed, "decisions from experience and decisions from description can lead to dramatically different choice behavior." (Hertwig et al. 2004, p. 534). Their results suggest that direct experience of outcomes leads to underweighting, i.e., in decisions based on experience, rare events had less impact than in decisions from descriptive. At the same time, theoretical and hypothetical choices do not motivate subjects to reveal their true preferences. Fan (2002) tested three small-payoff variants on the Allais paradox questions. For each variant, the probabilities were the same as in the original Allais questions; only the payoffs differed. There were both hypothetical and real payoffs and also negative payoffs. She found that whether payoffs were hypothetical or real, Allais paradox behaviour largely disappeared. As she summarized the behaviour was closer to simple expected value maximization when payoffs were real than when they were hypothetical.

Other side of the coin is that altruistic behaviour can be motivated. Fehr & Fischbacher (2003) highlighted the interaction between altruists and selfish subjects with human cooperation. Because a minor group of altruists can force a majority of selfish subjects to cooperate or, conversely, a few egoists can influence a large number of altruists to defect. They tested the effect of punishment and reward in case of altruism. Calabuig et al. (2016) investigated effect of punishment in an experiment with endowment heterogeneity. Using within-subjects designs they found that endowment effect disappear with punishment. Therefore, punishment has an opposite psychological effect on intrinsic motivation. Friendship and subjective positive feelings between owners and decision makers improve rationality through shared responsibility (e.g. unwritten businesspersons' agreement).

According to Camerer (1998), some studies concentrated on fitting theories to individuals. As it was mentioned earlier risk taking preferences might be take in

account, Palmer et al. (2013) detailed how individual differences can be measured but they mentioned cross cultural differences, as well. Baillon et al. (2016) compared the rationality of group decisions with individual decisions under risk. Participants were required to choose between two options that based on Allais problem. They found that communication helped to find more moral rational decisions, and the groups violated less axioms and were more

rational than individuals did. It seems that group decision drives to more rational choices because solves the feeling of uncertainty. It should be underlined that some researchers confuse risk and uncertainty (like Robison at al. (2010) used the terms: decision under uncertainty, in contract Kahneman & Tversky (1979 used decision under risk) but they are not equal to each other. In this paper these two phenomena will not be differed (please find it detailed in

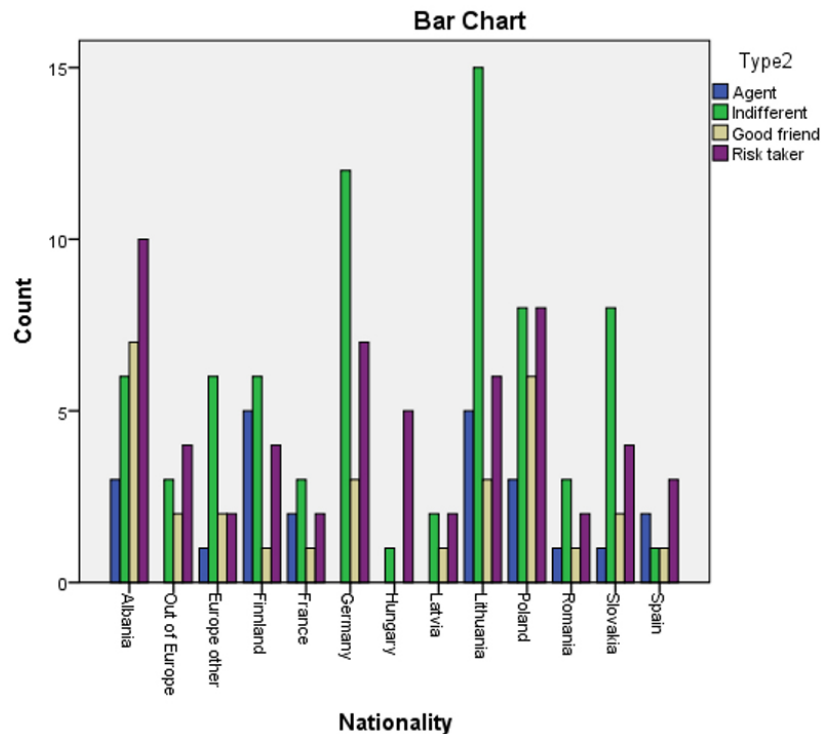


Figure 4: Sample statistics regarding ethnicity (capita) (Own resources)

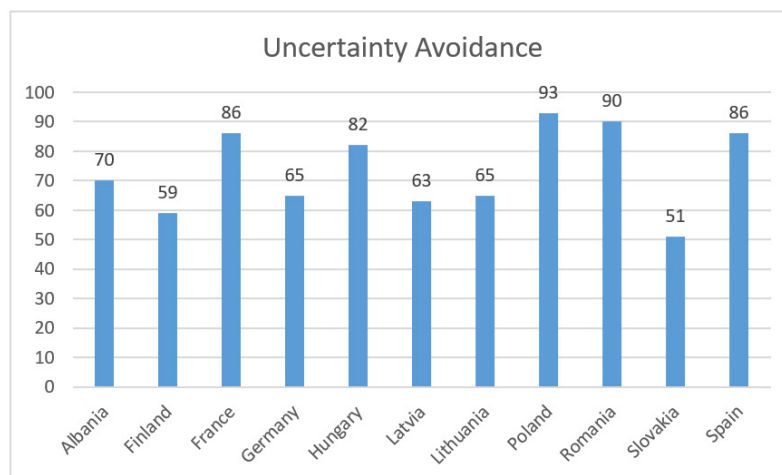


Figure 5: Sample statistics regarding ethnicity (capita) Based on Hofstede Centre's results)

Kolnhofer-Derecskei & Nagy 2017). Here I just agree with Andreoni & Sprenger (2010) that Allais problem might be connected with uncertain and certain effect. Managing uncertainty among different cultures is measured by Hofstede (2017). In his definition, uncertainty is the following: “The Uncertainty Avoidance dimension expresses the degree to which the members of a society feel uncomfortable with uncertainty and ambiguity.” (Hofstede, 2017). UA Indexes of participants are indicated in Figure 4. These results based on findings of Hofstede’s Centre<sup>2</sup>.

In this paper, ethnicity was related to the different roles. That means there were significant differences in both cases (i.e. Group A and Group B) regarding nations. (Kruskal-Wallis with sig. level 0.05  $p < 0.005$ ). However, these results can be caused by the non representative sample selection methods. Descriptive histograms in Figure 4 show some differences among participants’ cultural backgrounds.

Comparing Figures 4 and 5, it can be realized that in case of Albania (where the number of the participants was also acceptable) should be some relationship. UA Index is not so high which can explain the salient number of risk-takers.

## 5 Conclusion

Yet, what is the evidence of this paper? The importance of learning and knowledge helps us to avoid irrationalities due to basic misunderstanding and lack of motivation. As Birnbaum (2008) suggested a long experiment is possible that people might learn stochastic evidences.

That is the reason why it is useful to observe this old-fashioned effect. If we find predictable patterns of irrationality in human behaviour, then we can improve economic theory. I agree with Maletič et al. (2017) that the increasing turbulent business environment means that organizations are constantly faced with either uncertain and/or competitive environments. Hence it is recommended to adopt and use such kind of managerial practices (e.g. Maletič et al. (2017) suggested PAM) and KPIs which help and control uncertain and risky decisions.

Closing this chapter, I would quote Herbert Simon (1978 p. 361), who said the following in his Nobel lecture “I have perhaps said enough also with respect to the limitations of these new constructs to indicate why I do not believe that they solve the problems that motivated their development.” I hope that this paper helps to understand how psychological issues can improve decision makers in a business area.

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<sup>2</sup> Secondary data are downloaded from <https://geert-hofstede.com/countries.html> on 05/2017

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### **Indiferentni, dobri Samaritan, hrabri in agent v položaju Allais-ovega paradoksa: kako učinek lastništva vpliva na našo odločitev v primeru Allais-ovega paradoksa?**

**Ozadje in namen:** Glavni ekonomski modeli ne upoštevajo lastništva, čeprav učinek lastništva kažejo ugotovitve vedenjskih ekonomistov. Ta učinek pomeni, da je blago, ki ga nekdo ima v lasti, vrednoteno višje od drugega blaga, ki ni v njegovi ali njeni posesti. Obenem se literatura glavnega agenta ukvarja s tem, kako lahko glavni agent (kot je n.pr. delodajalec) motivira svojega agenta (recimo delavca), da deluje tudi v interesu glavnega agenta. Poglavitni problem je, da lahko delovanje v interesu nekega drugega vpliva tudi na naše vrednote. Poleg tega učinek lastništva vpliva tudi na glavnega agenta. Obe situaciji je mogoče obravnavati kot tvegano odločitev. Tveganje namreč zmede našo racionalnost na predvidljiv način.

**Oblikovanje / metodologija / pristop:** V članku raziskujem, kako so se študentje ( $n = 186$  odgovorov) iz različnih kulturnih okolij odločali v tveganim finančnem položaju, s posebnim ozirom na klasične Allais-ove igre. Predstavila sem tudi njihove preference glede gotovih in negotovih izidov upoštevajoč lastnika končnih izidov; to je, kako se odločijo, ko se odločajo za sebe ali za enega od svojih najboljših prijateljev. Eden od znanih eksperimentov, ki so testirali veljavnost pričakovane uporabne teorije aksiomov, je bil Allais-ov eksperiment. Allais je obravnaval verjetnosti in izide v izrazito hipotetičnih situacijah v finančnih igrah. Zanima me, kaj se zgodi, ko udeleženci tvegajo v imenu drugih. Uporabljena je bila tehnika med subjekti na razširjenem večkulturnem vzorcu. V zvezi z dvema različnima temama smo testirali tri hipoteze (1) prva temelji na Allais-ovem paradoksu, (2) druga na percipiranem lastništvu in (3) na primerjavi obeh pojavov.

**Rezultati:** Rezultati kažejo, da so se subjekti drugače odzvali, ko so se morali odločiti o svoji lastnini, kot takrat, ko so odločali o lastnini drugih. Ko je bil subjektom ponujen tudi varen izid, so sprejemali večje tveganje v imenu svojih prijateljev, kot v svojem imenu. Subjekti niso upoštevali, da bi morali prezreti lastništvo. Tako je bil potrjen Allais-ov paradoks.

**Zaključek:** V članku je bila vzpostavljena je bila konceptualna povezava med vedenjem vrste Allais in problemom lastništva. Drugič, Allais-ov aksiom je bil uporabljen za označevanje različnih vlog. Poznavanje predvidljivih vzorcev navidezno iracionalne heuristike v človeškem vedenju lahko izboljša ekonomsko teorijo. Hkrati to znanje nam pomaga preprečiti neracionalne odločitve.

**Ključne besede:** *Allais-ov paradoks; učinek lastništva; problem glavnega agenta; tveganje*



## Appendix

*Allais variant A* (if the birthday number of the respondents is even)

Suppose you have just won 100 million USD in a gamble. What would you do?

It's up to you whether you

- keep a sure gain of 100 million USD and quit the game OR
- you go on, continue the gamble, where there's a 10% chance of 500 million; 89% chance of 100 million; 1% chance of nothing.

Suppose one of your best friends is in the same situation but you have to decide instead of him/her. Which would you choose for him/her?

- He/She has to quit and keep a sure gain of 100 million USD
- He/She has to continue the gamble with the before mentioned assumptions / conditions.

*Allais variant B* (if the birthday number of the respondents is odd)

Two gambles are offered to you but you can take part only in one of them. Which do you prefer?

- With a 11% chance you win 100 million USD and with a 89% chance you win nothing OR
- There's a 10% chance that you win 500 million USD and an 90% chance that you win nothing.

Suppose one of your best friends is in the same situation but you have to decide instead of him/her. Which would you choose for him/her?

- With a 11% chance he/she wins 100 million USD and with a 89% chance he/she wins nothing OR
- There's a 10% chance that he/she wins 500 million USD, and 90% chance that he/she wins nothing.

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# Hotels and Halal-oriented Products: What Do Hotel Managers in Slovenia Think?

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**Background and Purpose:** Tourists from the Islamic world are significant stakeholders in the tourism market. The purpose of this paper is to identify the key aspects of halal tourism in connection with the hotel industry. Furthermore, we want to determine whether hotel managers are familiar with halal certification and on what basis they would opt for it.

**Design/Methodology/Approach:** The research focuses on halal goods, services, and facilities, in general, and specifically in Slovenian hotels; concepts, contemporary trends, and the situation in Slovenia are presented. In response to the literature review, we applied the analysis of the factor loadings to define the important factors that influence the decision-making process; by applying PCA, we reduced the dependent variable to a single factor (although predictions were slightly different).

**Findings:** The most important elements in the adoption of the certificate are the simplicity and efficiency of the procedure itself and the fact that the process does not require major financial investments. The element that significantly influences the managers' decision-making process is the possibility of adjusting to the standard of the certificate.

**Conclusion:** The paper's main contribution is to deepen the perspective of the development of tourism in an area that remains a relatively undeveloped and unknown niche within the Slovenian tourism/hospitality industry but very promising in the global context.

**Keywords:** *hotel managers; halal certificate; Islam; thematic offer; Slovenia; Croatia*

## 1 Introduction

Muslim tourists are significant stakeholders in the tourism market, although the Western world until recently has viewed them, for example, only as pilgrims to Mecca. Undoubtedly, in recent years there have been major shifts in the travel habits of the Muslim population. Muslim tourists are one of the fastest growing segments in the world, second only to Chinese tourists (Aladjem, 2012). They can be defined as guests who are just entering the global tourism market, with increased purchasing power and a strong desire to pursue their social status (Onislam.net, 2010), seeking a holiday in places where they can follow their religious principles and have access to services which are

in accordance with their lifestyle (Aladjem, 2012).

According to recent research of Dinar Standard (2012) in 2011, Muslim tourists spend about 102 billion Euros on their travels. Moreover, they are characterised by a dominant share of young people, since nearly half of the world's Muslim population is younger than 24 years. By 2030, the global proportion of young Muslims will grow twice as fast as the share of young people in non-Muslim countries (Baker, 2011); considering the entire world Muslim population, which has 1.8 billion people, and is rapidly increasing and is expected to represent 30% of the world population by 2025 (Dinar Standard, 2012). Young people are educated, and eager to gain new knowledge and discover new places (Baker, 2011); more than 52.7% of Muslim tourists

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travel for leisure and entertainment, with 50% of them preferring halal services, 30% would seek services that are fully consistent with sharia law (Dinar Standard, 2012). The data show that it is not a narrow market niche, but a significant trend that will have a strong impact on the global tourism sector in the coming years (Razalli, Yusoff & Roslan, 2013). The specific needs of Muslim guests raised the demand for adjusted products and services, which are known as 'halal'. This is defined as a sub-category of religious tourism and includes airlines, travel agencies, tour operators and hotels (Henderson, 2010). The concept of halal appeared more frequently in connection with food, which is prepared in accordance with Islamic principles,<sup>1</sup> but today it indicates a wide range of different products and services, e.g. financial operations, cosmetic products, vaccines, and last but not least tourism services (Piangpis, Oraphan & Hamzah, 2014). Consequently, in recent years, many countries in the world have shown an incrementally increasing interest in the concept of halal tourism (Battour, Ismail & Battor, 2011). Therefore, the primary purpose of this study is to present the fundamental aspects of halal tourism in connection to the hotel industry.

Since 1991,<sup>2</sup> Slovenian tourism has developed and grown with above-average dynamics. It has contributed almost a 13% share of the GDP in recent years and employs approximately 13% of all employees in the country. It is very internationally oriented: the main sales markets are Italy, Austria, Germany, and Croatia. Around 60% of tourists use hotel accommodation, followed by campsites (Slovenian tourist board, 2017; Slovenian tourist board, n.d.). However, in Slovenian tourism, the topic of halal products and services is completely unexplored and was not included in the 2012-2016 Slovenian Tourism Development Strategy (The Government of the Republic of Slovenia, 2012) or The 2017-2021 Strategy for the Sustainable Growth of Slovenian Tourism (The Government of the Republic of Slovenia, 2017). For example, in February 2016, only five halal-certified hotels were operating. The fieldwork of this study was conducted in the fall of 2015 in order to determine the attitude of managers of hotels with at least three stars toward services for Muslim guests. Our search in COBISS (Co-operative Online Bibliographic System and Services), HRČAK (Portal of Scientific Journals of Croatia) and in large international bibliographic indexes such as Emerald, Elsevier, and the Taylor & Francis Group indicates that no research of this kind has been published.

## 2 Islam as the basis for the tourist engagement

Islam is a religion that strongly encourages travel. Among Muslims, it is believed that they are closer to God when they travel and that their prayers during the journey are more effective (Timothy & Olsen, 2006; Kovjanic, 2014). In Islam, historically speaking, there were many different types of travel with significant religious roles, which changed and adapted over time (Henderson, 2003). It is especially important to emphasise that the act of travelling in Islam is 'purposeful', with a strong emphasis on the religious impulses: to strengthen the relationship between the broader Muslim community or *umma* (*Ummah*, *Ummet*) and the continuation of the long history of Muslim travels (Henderson, 2003; Kovjanic, 2014); the Muslim religion is a way of life (Boisard, 2002) or life itself (Nasr, 2007). In compliance with sharia law, Muslims place a high value on the tourist experience and rely heavily on the ethical dimension and tradition, which is not always typical for the tourists from the Western world (Sureerat et al., 2015).

When Muslims decide on tourist destinations, they particularly pay attention to halal food (67% of them), the overall value (53% of them), and the experience being suitable for Muslims (49% of them) (Baker, 2011); when they travel to distant places, they travel in groups, which is also encouraged by the Islamic tradition. Thus, the majority of Muslims around the world decide to travel in the company of family members and friends (Timothy & Olsen, 2006, p. 199; Aladjem, 2012). Hence, their holiday calendar is designed differently than in other cultures/religions, where most people go on vacation during certain seasons or times of the year (Aladjem, 2012): Muslims are guided by the lunar calendar and follow the phases of the moon, and thus go on vacations in different periods of time and to different locations/destinations. *Ramada* month (*Ramazan*) with the feast of *Eid al-Fitr* (*Bajram*) and the feast of *Eid al-Adha* (*Kurban Bairam*) are the central events in the traditional holiday calendar when many Muslims choose to travel.

## 3 Halal (tourism) and hotels

Halal tourism is defined as a sub-category of religious tourism that includes airlines, travel agencies, tour operators, hotels (Henderson, 2010), food and beverage providers, logistics, finance, tourism packages, SPA centres (Zulkifli et al., 2011) and any other guest activities regarding the consumption of products and services adjusted to Islamic principles (Duman, 2011). Irrespective of the product classification, the main attributes of halal tourism are based on factors that satisfy the basic religious needs of Muslim guests: access to halal food, prayer facilities (Battour,

<sup>1</sup> More can be found in Food and Agriculture Organization of the United Nations (FAO) (n.d.).

<sup>2</sup> The year of the proclamation of the independence of Slovenia.

Ismail & Battor, 2001; Hashim, Murphy & Muhammad, 2007), discrete dress code (Henderson, 2010), ban on the sale of alcoholic beverages, and the prohibition of gaming services (Din, 1989).

The hotel industry has established the concept of (a) the halal hotel that is fully operational in accordance with Islamic principles<sup>3</sup> and (b) the halal-friendly hotel, which, in addition to its existing range of services, also offers services tailored to Islamic principles. The halal hotel is not restricted to supplying only halal food and drinks, since all hotel services/activities are carried out in accordance with Islamic principles (Sureerat et al., 2015). Henderson (2010) was the first to indicate the basic characteristics and attributes of halal hotels. Halal hotels attract mostly conscious guests who respect and appreciate the environment, culture, heritage, well-being, and the green character of the place (Al Bawaba, 2007), which could be more profitable than offering standard hotel services (Morgan, Pritchard & Piggott, 2002). In any case, the halal certificate is a successful marketing tool for promoting halal trademarks or services (Rajagopal et al., 2011), giving the halal-certified hotel an added competitive advantage for attracting foreign and domestic guests (Zaliani, Omar & Kopong, 2011), whether they are religious or not.<sup>4</sup> The process for obtaining the halal certification has a favourable effect on the six dimensions of the performance of the hotel: the qualifications of the hotel staff, employee motivation, increased the range of skills of employees, better efficiency, environmental awareness, and economic wisdom (Razalli, Abdullah & Yusoff, 2012). Obtaining the halal certification, in fact, depends on the adjustment of certain hotel processes, greater emphasis on quality control, and the training of hotel staff.

The global halal tourism market in 2013 reached a value of around 140 billion USD, which represents approximately 13% of the total world tourism industry and is 60% more than three years before (Crnjak, 2014); according to Rezidor Hotel Group it is estimated to increase by 20% in the next decade (Saad, 2013). In addition to its rapid growth halal tourism also brings guests who spend much more money, on average about 1,700 USD per day than Europeans, who spend on average 500 USD (Saad, 2013); Kovjanic, 2014, 36). The trend, of course, has been quickly detected by many tourism service providers who aligned to the needs of the new segment with the acquisition of halal certificates. In this context, two completely different examples are highlighted in the following sub-chapters.

### 3.1 Halal concept in the Croatian hotel industry

Croatia has already declared itself to be a halal-friendly destination and started an extensive campaign to promote their halal offerings, which resulted in high media coverage, e.g. Crnjak (2014), Šoštarić (2014), Latinović (2016). Croatia is also the first country in the European Union to have standardised the certification procedures and is also actively engaged on the international level in order to reach an agreement between countries on a uniform procedure of certification. In December 2014, Croatia had 12 certified accommodation facilities (Crnjak, 2014); the updated list is available on the website of the Centre for Halal Quality Certification of the Islamic Community in Croatia (<http://halal.hr/pruzatelji-uslugu/>).<sup>5</sup> Experiences of some hotels in Zagreb, which already have the halal certificate, show that the halal certification is a good opportunity for the development of not just leisure tourism, but also of congress tourism. For example, the certified hotels in Zagreb have hosted the Olympic basketball team and handball team from Qatar, a football club from Saudi Arabia, a youth football team from Kuwait and several business delegations from the Middle East (Crnjak, 2014). One factor that has undoubtedly helped is also the direct air connection of Qatar Airways and the opening of the Qatari embassy in Zagreb, as well as business associations and investments in general (Šoštarić, 2014). According to PR data from the Hotel Esplanade, it is clear that since the introduction of halal standards, the hotel profit increased by 6% in 2013, while the number of overnight stays increased by 4% (Grgić, 2014).<sup>6</sup> Croats hope that by strengthening the halal supply they will manage to prolong the tourist season and to enhance the development of medical tourism, which is becoming increasingly interesting to the Arab markets (Pavičić, 2014; see also Ištaković, 2012).

### 3.2 Halal concept in the Slovenian hotel industry

In Slovenia, the concept of halal is still relatively undeveloped. In contrast to other EU countries, which have various halal butcher shops, restaurants, perfumeries, and personal hygiene products, the offer of halal products and services is predominantly poor in Slovenia. Apart from a

3 Caprice Hotel from Turkey, Al-Jawhara Hotel in Dubai, Hotel Sofyan Hotel and Hotel Tuara Natama in Indonesia, and DePalma Hotel in Malaysia were the first hotels to be transformed into halal hotels (Razalli et al., 2013).

4 Sixty per cent of the guests at *Jawhara Hotels*, an Arabic halal hotel chain, are non-Muslim, who appreciate its staff friendliness and family atmosphere (Alserhan, 2011); the biggest advantage of halal hotels is the spiritual experience (Rosenberg & Choufany, 2009).

5 Under the auspices of the Ministry of Tourism and three other ministries, the centre organised the World Halal Day Croatia 2016 in November of that year (Croatian Chamber of Economy, 2016).

6 However, figures have to be understood in the context of public relations (PR), which is the usual technique of corporations. Apart from that, we have to take into consideration that so many other factors impact the hotels' performance (including profit).

Table 1: Structure of the population and the sample according to the hotels' category

Hotel category	No. of hotels	
	Population	Sample
3*	175	14
4*	122	19
5*	9	1

few manufacturers of food products that have been halal certified, and some trading companies, there are no other providers of these products and services (Kalčić, 2007, p.9; Pašić, 2009, p.49; Batagelj et al., 2014). In the hotel industry, the halal offer is also modest (see '1 Introduction'), and this area is not a theme of academic research. Accordingly, within the hotel industry it is necessary to start practically at the beginning, which means that it is necessary to first determine the knowledge of the hotel management about this topic and consequently identify the opportunities for progress that would be consistent with the identified trends at the global level; the main question is: to what extent are hotel managers familiar with the halal certification and on what basis would they decide on its implementation? Relying on existing studies is problematic, because they are rare (Samori & Sabtu, 2012), characterised by political, economic and cultural differences: conducted on halal hotels in Muslim countries, e.g. Samori & Sabtu (2012), Afifi (2014); focused on halal tourism in general, e.g. Al-Borzooei & Asgari (2013), Hamameh & Steiner (2004), Razzaq, Halla & Prayag (2016), Battour, Ismail & Battor (2010), Kovjanic, (2014), Battour & Ismail (2016); focused on the global halal tourism market and its potentials (Crnjak, 2014; Saad, 2013; Kovjanic, 2014, p.36); focused on six dimensions of performance of the hotel (Razalli, Abdullah & Yusoff, 2012) or focused on the (processing) industries, which are not directly related to tourism, e.g. Demirci, Soon & Wallace (2016), Farouk, Puffaff & Amir (2016). Furthermore, we could not find any research that would highlight the views of managers regarding the halal offer in hotels (see "1 Introduction"). Consequently, based on the meta-analysis, this paper proposes the following claims:

- *C1: Slovenian hotel managers are not familiar with the halal certificate.*
- *C2: Decision-making related to certification is at least two-dimensional.*

## 4 Methodology

In the study, Slovenian hotels categorised with three stars or more, which are recorded in the register of the Slovenian accommodation providers ([www.slovenia.info/register-NO](http://www.slovenia.info/register-NO)) were considered. Hotels with gaming activities were discarded, because these kinds of services are incompatible with Islamic principles. After this selection process, the population was obtained, summarised in Table 1. By applying the method of random sampling, 100 hotels were selected, and a questionnaire was sent by e-mail to the hotel managers (respondents). In total, 34 completed surveys were obtained, which represents 11% of the population. The size (in relation to the category) of this sample was problematic for further analysis; consequently, some adjustments (weighting) to correct for under-representation of certain characteristics were implemented.<sup>7</sup>

We relied on the assumption that for the research it is particularly important to obtain information from the part of the researched population with representative members of a target group (Altinay & Paraskevas, 2008). Therefore, we accept the fact that we operate with a small and then weighted sample, which can additionally be defined by the following characteristics:

the shortest operating period of a hotel is 2 years, while the longest operating period is 101 years. On average, hotels had been operating for 21.87 years;

the hotel with the lowest number of employees has 4 employees, while the largest has 200 employees. The average number of employees per hotel in the sample is 26;

74.2% of hotels are independent organisations with one hotel.

The development of the questionnaire was a more complex process, since it was done on the basis of the objectives of the research for reasons mentioned at the end of the previous chapter ('3 Halal (tourism) and hotels'). A preliminary web questionnaire pertaining to managers' perceptions was initially developed from the relevant research, i.e. Rosenberg & Choufany (2009), Henderson (2010), Razzalli, Abdullah & Yusoff (2012), which were focused on different perspectives of halal context. The questionnaire has been based on the Technological Acceptance Model (TAM), developed by Davis (1989), which represents an extension of the theory of rational action

<sup>7</sup> This intervention impacted all further calculations.



(Theory of Reasoned Action (TRA)) (Fishbein & Ajzen (1975); Ajzen & Fishbein (1980)). The final version of the questionnaire, which was the result of interviews with three experienced researchers, included 11 questions with dichotomous or ordinal variables, with the level of agreement on a scale of 1 to 5, where 1 marked the lowest level of agreement, 5 the highest. The following ordinal variables (claims/questions) were included in the questionnaire:

- Q1 How well do you know the halal certificate for hotels, which includes hotel standards adapted to the needs of Muslim guests?
- Q2 The decision on obtaining the halal certification depends on the amount of information about its positive impact on the hotel performance;
- Q3 The possibility for adapting the existing hotel services and facilities to standards required by the halal certificate;
- Q4 The decision to obtain the halal certificate depends on the simplicity and effectiveness of the procedure for obtaining the halal certificate;
- Q5 The decision to obtain the halal certificate depends on the amount of financial investment required for obtaining the halal certificate;
- Q6 The decision to obtain the halal certificate depends on the increase in the number of Muslim guests;
- Q7 The decision to obtain the halal certificate depends on the decisions of other Slovenian hotels about certification.

The survey was conducted in the winter of 2015. The acquired data were then statistically analysed using the SPSS 20.0 statistical software package, with which the calculations were made using the descriptive analysis, principal component analysis (PCA) and analysis of the factor loadings. A 0.05 significance level was chosen before the data analyses.

## 5 Results

At the beginning of the empirical analysis, some basic calculations were carried out, which served to verify the data obtained, which is particularly important because of the way the research instrument was developed. First, the relatively low average values ( $\bar{x}$ ) characterise the variables from Q1 to Q7 (see Table 2). However, the high Cronbach  $\alpha$  (0.890) indicates a high reliability of the construct.

Second, the Spearman correlation test was employed to verify the correlation between all included variables that influence the decisions of hoteliers for a halal certificate and the category of the hotel. The decision related to possibilities to adjust the services and facilities to the requirements of the halal certification (Q3), the decision to obtain the halal certification if the latter would not require significant financial investments (Q5) and the decision to obtain the halal certification if this would increase the number of Muslim guests (Q6) show values  $0.387 \leq \rho \leq 0.653$ ,<sup>8</sup> which indicates a significant correlation between these variables and the hotel category; four-star hotels reach the highest average ratings. Lower positive correlation is evident with the decision that depends on the amount of information about its positive impact on the hotel performance (Q2) –  $\rho = 0.168$ . The same calculation was made for the connection between the same ordinal variables and the dichotomous variable *hotel is part of a hotel group*, for which all the coefficients were in the interval  $-0.331 \leq \rho \leq -0.168$ . This suggests that the decision on the halal offer is not linked to the internal structure (organisation) of the hotel organisation.

Third, results in Table 2 reflect the fact that Slovenian hoteliers (managers) have not (yet) developed a positive opinion on the halal certificate. This is also supported by the high coefficient of variation, which is indicated by the spread of answers. In addition, with the descriptive analysis of the two additional variables, we have found that more than half of the respondents are familiar with the concept of halal tourism (52.6%), but the proportion of

Table 2: Descriptive statistics (Source: authors)

\* weighted sample

Variable	n1*	Minimum	Maximum	$\bar{x}$	$\Sigma$	$\gamma_1$	$\beta_2$
Q1	306	1	5	1.58	0.936	1.852	4.147
Q2	306	1	5	2.50	0.844	0.961	0.438
Q3	306	1	5	2.55	0.913	0.858	1.222
Q4	306	1	5	2.71	1.002	0.869	0.088
Q5	306	2	5	2.83	0.925	0.819	-0.342
Q6	306	2	5	3.10	1.021	0.514	-0.885
Q7	306	1	5	2.48	0.843	0.820	0.525

<sup>8</sup> Correlation is significant at the 0.01 level (2-tailed).

those who have not even thought about obtaining the halal certification for their hotel is dominant (73.1%).<sup>9</sup> Consequently, C1 was confirmed. It is necessary to point out that the highest  $\bar{x}$  present variables for which the decision to obtain the halal certificate depends on the increase in the number of Muslim guests (Q6) and decisions to obtain the halal certificate would not require major financial investments (Q5).

Our intention was also to define the managers' decision to obtain the halal certification as a new construct. Therefore, we used a multivariate PCA method. In this way, we gained new information on the structure of the variables and created new factor(s). Initially, variables Q1 and Q3 were excluded from the analysis (does not relate completely to the managers' decision-making). We wanted to make sure that the correlation between variables is large enough to allow us to replace the basic variables with the principal components. The high value of the KMO coefficient (0.801) and the significant Bartlett's test of sphericity

( $\chi^2 = 952.436$ ,  $df. = 10$ ;  $p < 0.000$ ) allowed us to continue with the multivariate analysis. To determine the main factors affecting the decision on obtaining the halal certification, we employed the analysis of the factor loadings. The results show how the highest factor determines the most important factor affecting the decision to accept the halal certificate, which is the simplicity and efficiency of the procedure itself (Q4) (see Table 3). In the second place is the fact that the process does not require a major financial investment (Q5), and least influential is the information on the positive impact on hotel performance (Q2). Next, we used PCA method to reduce the dependent variables to a smaller number of factors. One factor with eigenvalues greater than 1.00 that explained 66.20% of the total variance was identified (see Figure 1). This suggests that the scale items are uni-dimensional. The identified factor can logically be called *decision making*. Consequently, C2 was rejected.

Table 3: Analysis of the factor loadings of the main components (Source: authors)

Component 1		$\bar{x}$	$\Sigma$
Q4	0.934	2.71	1.002
Q5	0.892	2.83	0.925
Q6	0.817	3.10	1.021
Q7	0.731	2.48	0.843
Q2	0.664	2.50	0.844

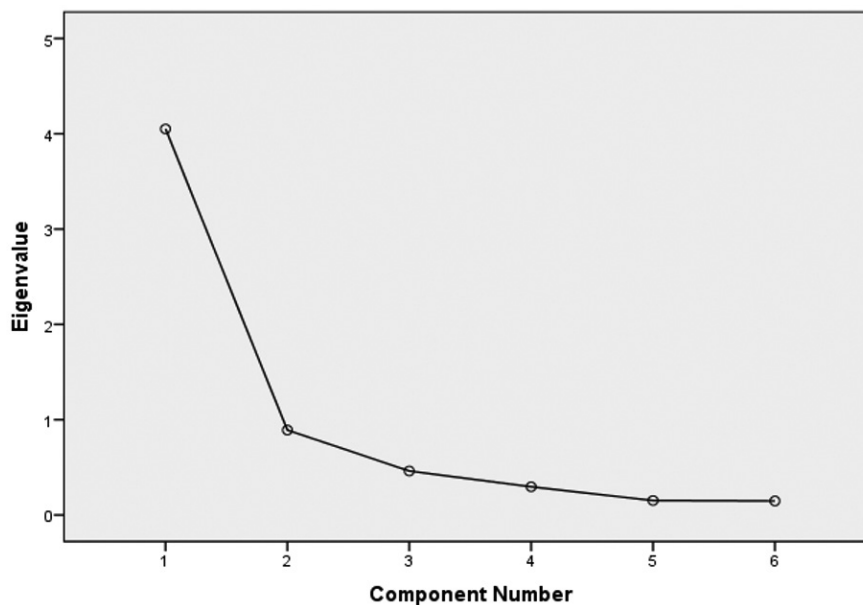


Figure 1: The component's eigenvalues (Source: authors)

<sup>9</sup> Both variables are dichotomous.

## 6 Discussion and conclusion

The main contribution of this study is to deepen the perspective of the development of tourism in an area that remains a relatively undeveloped and unknown niche within Slovenian tourism, yet very promising in the global context. Based on this assumption, Slovenia could increase the visits of Muslim tourists by incorporating halal content in its tourism services and facilities, since it already offers many features that appeal to the Muslim guest, e.g. culture, history and art, wellness. According to the (research) claims, we established that Slovenian hotel managers are not familiar with the halal certification and, therefore, are not taking it into consideration; their decision-making process for adopting the halal certificate would be determined by the simplicity and efficiency of the procedure itself and on the fact that the procedure does not require a major financial investment. The certification procedure remains quite unclear and inconsistent. This is problematic: Islamic communities are tied to each country, and the interpretation of certain religious aspects may also differ between them; a unified mechanism for certification on the international, European or global, level has not been yet established (Rosenberg & Choufany, 2009; see also Crnjak, 2014; Obućina, 2014). Institutionalised practices for the certification of halal hotels as well as institutions that would define uniform criteria about the conditions for obtaining a halal certificate does not yet exist on the market (Henderson, 2010). Hence, findings on the efficiency of the procedure itself and on financial investment are basically consistent with the allegations of Razzalli, Abdullah and Yusoff (2012) on the dimensions of the hotel performance, which includes the effectiveness and economic prudence. Due to the significant cultural/religious differences, halal adjustments may affect certain hotel services, hotels interiors, and other features (according to the characteristics of halal hotels indicated by Henderson, 2010); they are justified only when they have a significant (positive) impact on sales. Therefore, their implementations require additional caution in the decision-making process of hotel managers in Slovenia, where the Islamic religion is not dominant; managers' practical orientation and pragmatism are reflected in the decision-making process that would be influenced by the possibilities to adapt the existing hotel facilities and services to the standards determined by the halal certificate. The process of the adaptation of existing facilities and services should be supported by external partners, which could lead to the development of higher quality and more innovative products. Exactly this approach has been detected as a weak point of the Slovenian tourism (see Uran Maravić, Križaj & Lesjak (2015)).

The hotel industry recognises that an increased demand for certifications requires a consensus on uniform guidelines and standardised procedures to protect and ensure a

consistent quality of halal products and services (Halim & Salleh, 2012). Therefore, the EU has already begun the process to standardise the procedures for the certification and thus facilitate a transparent functioning of the necessary mechanisms (Obućina, 2014). The problematic aspect of the topic has also been shown by the results of our study, in which we found that hoteliers' decisions for adopting the halal certificate largely depend on the perception of the complexity and costs of the certification process. The interest of Slovenian hotel managers for a halal certificate could be increased by developing clear and simple procedures for obtaining the halal certification, which would favourably affect the perception of the degree of difficulty and the possibility to adjust to the standards of halal certificates. This would help hoteliers make decisions that would be in line with the global trends (see Dinar Standard (2012), Baker (2011) and Razzali, Yusoff & Roslan (2013)) and competitors in the neighbourhood (see Crnjak (2014), Šoštarić (2014), Latinović (2016)).

In order to improve the perception and understanding of the complexity of the process for obtaining the halal certificate, an interdisciplinary team consisting of (a) organisers or experts for standardisation, (b) experts of hospitality/hotel industry, (c) experts of halal standards and (d) religion/culture of Islam from Slovenia and/or abroad should define/develop: (a) clear halal standards for the hotel industry (in formal written form) and, on this basis, (b) special educational/training programs, including all the necessary consultations, (c) publicly available material (standards) and other quick information, e.g. via web page. In addition to these recommendations, it is necessary to strengthen the research of halal tourism in Slovenia, since this would help to overcome stereotypes and strengthen the awareness of hotel managers and other relevant stakeholders in tourism about the potentials/opportunities, to connect the specific business concept with the specific sectorial organisational culture<sup>10</sup> and provide a level of quality that is consistent with the expectations of the guests (see Parasuraman, Zeithaml & Berry (1985) or Kukanja, Gomezelj Omerzel & Kodrič (2016)). In this sense, this research could help develop national halal systems in Slovenia and in the wider region as well as improve the perception of hotel managers and facilitating an easier integration of services adjusted to the needs of Muslims (as well as other guests) in the hotel facilities and services; the perspective of corporate social responsibility (CSR) in the hospitality industry should not be neglected (see Kukanja, Planinc & Šuligoj (2016) or Štrukelj & Šuligoj (2014)).

This survey, like any scientific study, has certain restrictions. The constraints of the quantitative research include low response rates of hotel managers and a general lack of knowledge about halal services among Slovenian hotel managers. To ensure the representativeness of the results, weighting of the sample was required. Nevertheless,

<sup>10</sup> In general presented by Šuligoj & Mrđa (2016).

our study can be seen as a relevant (first) study on the specific form of the tourism/hotel industry. Another limitation is also represented by the use of an online questionnaire, which excludes the role of the interviewer and thus the possibility of the immediate elimination of possible confusions and mistakes in completing the surveys. An interesting example is variable Q3, which was not clearly linked to the decision making and consequently excluded from the calculations related to C2. As a general restriction, we can mention the absence of related research on halal tourism, which could be effectively used for the development of the instrument and for argumentation and interpretation of the final findings. Despite these limitations, with the use of selected methodology, the goals of the study have been successfully achieved.

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## **Hoteli in v halal usmerjena ponudba: kaj o tem menijo managerji hotelov v Sloveniji?**

**Ozadje in namen:** Turisti iz muslimanskih držav so pomemben deležnik na turističnem trgu. Namen tega prispevka je identificiranje ključnih vidikov halal turizma, posebej v hotelirstvu. Posebno nas je zanimalo, ali so managerji seznanjeni s halal certifikatom in ali bi želeli pridobiti certifikat.

**Design/Methodologija/Pristop:** Raziskava je osredotočena na halal izdelke, storitve in opremo v splošnem in posebej v slovenskem hotelirstvu; predstavljeni so koncepti, obstoječi trendi in razmere v Sloveniji. Poleg pregleda literature, smo za definiranje pomembnih faktorjev, ki pomembno vplivajo na proces odločanja managerjev, izdelali analizo faktorskih obremenitev; z uporabo metode glavnih komponent smo nabor odvisnih spremenljivk zmanjšali in oblikovali en faktor (čeprav so bila predvidevanja nekoliko drugačna).

**Rezultati:** Najpomembnejši elementi pri certificiranju so enostavnost in učinkovitost postopkov ter dejstvo, da postopek ne zahteva večjih finančnih investicij. Najpomembnejši element, ki vpliva na proces managerjevega odločanja, je možnost prilagoditve obstoječe ponudbe standardu, ki je del certifikata.

**Zaključek:** Glavni prispevek je v poglobitvi razvojnega vidika v turizmu na področju, ki je relativno nerazvita in nepoznana niša v slovenskem turizmu/gostinstvu, toda zelo obetajoča na svetovnem nivoju.

**Ključne besede:** *managerji hotelov; halal certifikat; Islam; tematska ponudba; Slovenija; Hrvaška*

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# Innovation Leaders, Modest Innovators and Non-innovative SMEs in Slovakia: Key Factors and Barriers of Innovation Activity

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**Background and Purpose:** The field of innovation represents for small and medium enterprises (SMEs) a fundamental challenge. If the number of innovative SMEs is to rise, it is necessary to identify key factors determining their innovation activity and eliminate the innovation barriers. The main purpose of the paper is to present the results of primary research focused on identification (evaluation) of key factors and barriers determining innovation activities in Slovak SMEs. The division of SMEs into three groups of enterprises: innovation leaders, modest innovators and non-innovators enables to identify the differences in managers' perception of the main factors and barriers determining innovation activities in various types of SMEs and to formulate policy implications for Slovak SMEs.

**Design/Methodology/Approach:** Results of the empirical research were processed using MS Excel and the statistical analysis of the data in R3.2.4. statistical system was done. For statistical tests we assumed significance level ( $\alpha = 0.1$ ).

**Results:** Evaluating the importance of the key factors a majority of enterprises (64.71%) indicated financial resources as the most important factor for the innovations. There is no statistically significant difference in individual (analysed) factors between innovation leaders, non-innovators and innovation followers (modest innovators). The results gained from Fisher exact test ( $p$ -value = 0.11) indicated a small difference in evaluating the significance of individual barriers between innovation leaders, non-innovators and modest innovators. Majority of enterprises also see as the main barriers to develop innovation activities bureaucracy and corruption and inappropriate state support of innovation activities.

**Conclusion:** The main implications (conclusion) coming from the research are basic recommendations for state policy makers as well as SME's managers to foster innovation activities in enterprises. They refer to the areas of financial resources, high-quality human resources, cooperation and participation of SMEs in different networks and clusters, systematic institutional support to SMEs, well-created vision and clearly formulated aims, and willingness of enterprises to innovate. Recommendations are summarised following the results of factor's and barrier's evaluation.

**Keywords:** *innovations; small and medium enterprises; factors; barriers; Slovak Republic*

## 1 Introduction

Innovations are declared as a priority in all European countries and a number of EU programmes are developed to support innovation activities in small and medium enterprises. Starting up the EU potential for growth is one of the key challenges of the Europe 2020 Strategy (European

Commission, 2010).

Innovations have been long time at the centre of a challenging scientific debate. The management guru Peter Drucker observes that "innovation is the specific tool of entrepreneurs, the means by which they exploit changes as an opportunity" (Drucker, 1985). Trushman, & Nandler (1996) focus on the firm in noting that "innovation

is the creation of any product, service or process which is new to the business unit". Another management guru, Michael Porter, shifts the focus of attention by highlighting that innovation cannot be treated solely from an individual or firm level since the process of innovation is embedded within the national or regional context (Porter, 1990). The OECD definition describes innovation as a restoration and widening of product and market portfolio, as new designing, manufacturing and distributing methods, as implementation of changes in work organization and labour force skills, etc. The guidelines on measurement of innovation the OSLO Manual (OECD, 2005) define innovation as "the implementation of a new or significantly improved product (good or service) or process, a new marketing method, or a new organisational method in business practices, workplace organization or external relations".

Although innovation has been studied already for the second century, so far there is no common definition of it. The current approach to innovations maintains that innovation is a key word for entrepreneurs, it emphasises a global approach to innovations as a philosophy (way of managing enterprises) which influences all parts of transformation process in the enterprise (marketing, research and development, planning, manufacturing, managing, etc.) (Adair, 2009). According to Bessant, & Tidd (2009), for small and medium enterprises, innovation can be a way to gain a competitive advantage. Cooke, & Wills (1999) stress that innovations help reinforce the market position or gain a larger market share, increase the effectiveness of operations and improve the reputation. Thus, the ability to compete in innovations plays a very important role as a factor of competitiveness, and strengthening innovation activities is one of the main tasks of all types of businesses.

In the last years the role of innovation on SME's survival has received in theoretical and managerial literature a great deal of attention (Di Cintio, Ghosh, & Grassi, 2017; Cheah, Lang, Snowden, & Watts, 2014; Lee, Lee, & Garrett, 2017). Much of the research has expanded its scope and included different types of innovation in the research (Maletič, et al., 2014). The innovation aspect of entrepreneurship has gained critical importance in almost all sectors (Peljko, et al., 2016). A wide range of new themes has appeared. One of them is the identification of key factors and barriers determining innovation activities in SMEs.

## 2 Factors and barriers determining innovation in SMEs

Innovation must be a natural part of any entrepreneurship today. Permanent and regular innovation is becoming a competitive necessity; to be successful in the future requires interrupting conventions (Jones, & Miller, 2007). This is a time of changes and the only way for an enterprise to be successful is to accept these changes, adapt to

them and utilize them.

With the development of innovation processes in all types of enterprises, the growing role of innovations is evident also in small and medium enterprises. Compared to large companies, SMEs have more benefits from the point of view of innovation processes, which can be their innovative advantage. In particular, SMEs have flexible and entrepreneurial management structures that allow them to adapt to the changing market and at the same time have no bureaucratic and administrative constraints. They use informal and effective internal communication, their managers are willing to take risk and they are able to exploit new high-risk markets. In spite of all the above mentioned advantages, small and medium enterprises have also some handicaps – not many of them own research capacities and they face a lot of financial problems.

Most of the previous research has paid attention to the managing innovation in large enterprises (Nooteboom, & Stam, 2008). A few studies were conducted to discover which factors contribute to innovation efforts in SMEs (Keizer, et al., 2002). Following Keizer, et al. (2002), the factors that have an effect on innovation can be divided into internal and external, where internal variables (indicators) refer to the characteristics and policies of SMEs, while external variables refer to the opportunities that SMEs can seize from their environment. From the various studies of success and failure in innovation, it is possible to compile a checklist of factors affecting innovation activities. For our purposes, it will be helpful to build on the previous research and focus attention on a set of key factors significant for SMEs' innovation (Lesáková, 2014).

In our paper, we deal with a set of key factors that are driving innovation in small and medium enterprises and each of the factors is translated to partial indicators (based on Lesáková, et al., 2016; Nemeč, 2014):

- human resources (human potential) – number, structure and competencies of staff, share of highly educated people, leadership;
- financial resources (financial potential) – own funds and funds (private and public) available from financial and non-financial institutions;
- technology (material potential) – state of machinery, structure of production potential, ability to quickly adapt production to the changing needs of the market;
- cooperation with external entities (other enterprises, knowledge centres, universities, research institutions, other stakeholders) – forms of cooperation, participation of SMEs in networks and clusters, support for building partnerships, cooperation between SMEs, research institutions and universities;
- management of innovation activities in enterprises – created vision, clearly formulated goals and strategy, organizational structure, willingness to innovate, level of managing innovations in SMEs, organizational culture;

- system of state support for innovation – forms of innovation support, quality and amount of innovation support.

On the other hand, it is necessary to mention the main barriers to developing innovation activities; we have compiled a checklist of 11 barriers to innovation in Slovak SMEs: lack of internal financial sources, difficulty to obtain external financial sources, high cost of innovation, insufficient qualification of labour, lack of willingness to innovate, absence of innovation strategy, lack of cooperation with external entities, inappropriate system of state support for innovation, bureaucracy, corruption, lack of knowledge about the benefits of R&D in the enterprise (Lesáková, et al., 2016; Nemeč, 2014).

To obtain a complex view of the factors and barriers significant for innovation in SMEs, we divided all enterprises into three categories according to the introduced type of innovation:

1. Innovation leaders (successful innovative enterprises) – enterprises that introduced at least 3 product innovations, 3 process innovations, 5 organizational and 5 marketing innovations in the years 2010 – 2015.
2. Non-innovators (non-innovative enterprises) – enterprises that did not introduce any product innovation or process innovation in the examined period.
3. Modest innovators (innovation followers) – enterprises that belong neither to the group of innovation leaders nor the group of non-innovators.

Most of the existing research studies devoted to the evaluation of innovation activity in SMEs are based on the division of enterprises into two categories: innovative enterprises and non-innovative enterprises (Hoffman, et al., 1998; Keizer, et al., 2002; Radas, & Božič, 2009; Szczepańska-Woszczyzna, 2014). The reason why we decided to divide the entire sample of enterprises into more than two categories was to identify the difference in the significance of key factors and barriers determining innovation activities. It is obvious that there are enterprises which can be included neither in the category of innovative enterprises, nor the category of non-innovative enterprises. We used cluster analysis to process our data and it revealed that the enterprises are falling into three categories – the enterprises which are successful in innovation activities (innovation leaders), then the enterprises that could be marked as modest innovators (innovation followers) and the enterprises that do not perform any innovation activities (non-innovative enterprises). The above-mentioned groups of enterprises enable to obtain more accurate results about the key factors and barriers determining innovation activities in SMEs.

### 3 Aim, material and methodology

Theorists from different countries largely acknowledge innovation as a key driver of SME's performance and growth in contemporary market economies (Di Cintio, Ghosh, & Grassi, 2017). Innovation matters, not only at the level of the individual SME but also increasingly as the wellspring for national economic growth (Bessant, & Tidd, 2009). Most of the research studies confirm that innovations are the drive of SMEs development advancing the possibilities of their future competitiveness and increasing SME's economic efficiency and performance (Kressel, & Lento, 2012; Lee, Lee, & Garrett, 2017; Peljko, et al., 2016). For SME's management is therefore the critical task to identify key factors and barriers determining their innovation activities.

This paper aims to present the results of primary research focused on evaluation (identification) of the key factors and barriers determining innovation activities in Slovak SMEs. The division of SMEs into three groups of enterprises: innovation leaders, modest innovators and non-innovators enables to identify the differences in managers' perception of the main factors and barriers determining innovation activities in various types of SMEs and formulate policy implications for Slovak SMEs (recommendations for SMEs as well as policy makers) and thus improve the situation in this area.

Based on the research of different authors (O'Sullivan, & Dooly, 2009; Bessant, & Tidd, 2009; Keizer, et al., 2002; Radas, & Božič, 2009; Szczepańska-Woszczyzna, 2014) and our own previous research (Lesáková, 2014), we looked for answers to two main questions:

- Q1 – What are the main differences, if any, in the perception of various factors determining innovation activities in all three segments of SMEs: innovation leaders, modest innovators and non-innovators?
- Q2 – What are the main differences, if any, in the perception of barriers to developing innovation activities in all three categories of SMEs: innovation leaders, modest innovators and non-innovators?

Data for our research were collected in the period from November 2015 to January 2016. We used questionnaire as a method of primary data collection (see Appendix for details). Questionnaire was divided into three parts. The first part was devoted to the evaluation of key factors determining innovation activities, the second one to the evaluation of main innovation barriers and the last one to identification items. The questionnaire was distributed electronically through Google Docs to *randomly chosen* 998 enterprises of all size types (micro, small, medium size and large enterprises). We sent the questionnaire to top managers of these companies by e-mail. Sixty one of the enterprises responded and sent the completed questionnaire. After reviewing each reply, we set aside the answers



from large companies, as *our research was focused only on SMEs*. At the end, we collected 51 valid questionnaires from SMEs. After that, we processed the data through MS Excel, and made a statistical analysis of the data in R 3.2.4 statistical system. Based on criteria listed in Labovitz (1968) we decided to choose 10% significance level ( $\alpha=0.1$ ) for statistical tests.

The representativeness of the sample regarding the classification SK NACE (p-value = 0.1594) and region (p-value = 0.2824) was tested using Chi-squared goodness of fit test. Based on the test results, we concluded that our sample of enterprises can be seen as a reasonable sample of the entire population of small and medium enterprises.

The sample included 58.8% of micro enterprises, 23.5% of small enterprises and 17.7% of medium enterprises. It consisted mainly of enterprises located in the region of Bratislava (43.1%), which was most likely caused by the highest concentration of enterprises in this region. The second most frequent representation had enterprises from the region of Banská Bystrica (15.7%). In the sample, prevailed enterprises (firms) from the sector of manufacturing industry (19.6%), wholesale and retail (17.7%) and construction (15.7%).

According to the division of SMEs into the three categories (innovation leaders, innovation followers and non-innovative enterprises), 13 enterprises were classified as innovation leaders (25.5%) – in the years 2010 – 2015, they introduced at least 3 product innovations, 3 process innovations, 5 organizational innovations and 5 marketing innovations; 14 enterprises (27.5%) can be considered non-innovators – they did not introduce any product innovation or process innovation, and 24 enterprises (47.1%) were included into the group of innovation followers.

## 4 Results

Data collected by the questionnaire point to a rise of all types of innovations during the analysed period. They confirmed that most enterprises developed innovation activities in the year 2015. The number of individual types of innovations introduced in each year of the examined period is presented in Table 1.

To determine the proportion of enterprises that introduced a certain type of innovation, we used 90% confidence intervals (Table 2). From Table 2 it is evident that with 90% confidence, the highest proportion of product innovations were introduced in the year 2015 (from 45.6% to 71.6%), process innovations in the year 2014 (from 46.7% to 72.3%), organizational innovations in the year 2015 (from 0% to 15.3%) and marketing innovations in the year 2015 (from 44.5% to 70.9%).

Based on the research results, we could identify the types of innovations the enterprises introduced. During that period, the best enterprise introduced 20 innovations (5 product innovations, 5 process innovations, 5 organizational innovations and 5 marketing innovations) and the worst enterprise did not report any type of innovation. On average, the enterprises in our sample introduced 12.29 (SD = 5.25) innovations in the analysed period.

The first part of the questionnaire was focused on evaluation of the factors significant for innovation in Slovak SMEs. We created a checklist of six key factors: human resources, financial resources, technology, cooperation with other entities, management of innovation activities in enterprises and system of state support for innovation.

We assumed that Slovak SMEs do not evaluate the significance of these factors in the same way. To verify this premise, we used the Friedman test. This test rejected the null hypothesis that none of the factors is seen by Slovak

Table 1: Type of introduced innovations

Type of innovation	2015	2014	2013	2012	2011	2010
Product innovations	26	22	24	14	11	11
Process innovations	24	27	18	16	10	12
Organizational innovations	25	20	10	9	9	7
Marketing innovations	22	19	14	4	6	8

Table 2: 90% confidence interval for share of enterprises according to the type of innovation (%)

Type of innovation	2015	2014	2013	2012	2011	2010
Product innovations	45.6-71.6	36.8-63.2	41.1-67.5	20.4-45.2	14.7-38	14.7-38
Process innovations	40.1-66.2	46.7-72.3	27.7-53.3	23.7-48.9	12.6-34.8	16.2-39.6
Organizational innovations	0-15.3	0-12.2	0-8.7	0-8.4	0-8.4	0-8
Marketing innovations	44.5-70.9	33.3-60.1	13.2-36.2	11.4-33.7	11.4-33.7	7.9-28.4

SMEs as more or less important than the others (p-value = 9.066e-14) and supported our assumption that Slovak SMEs perceive the key factors significant for their innovation differently.

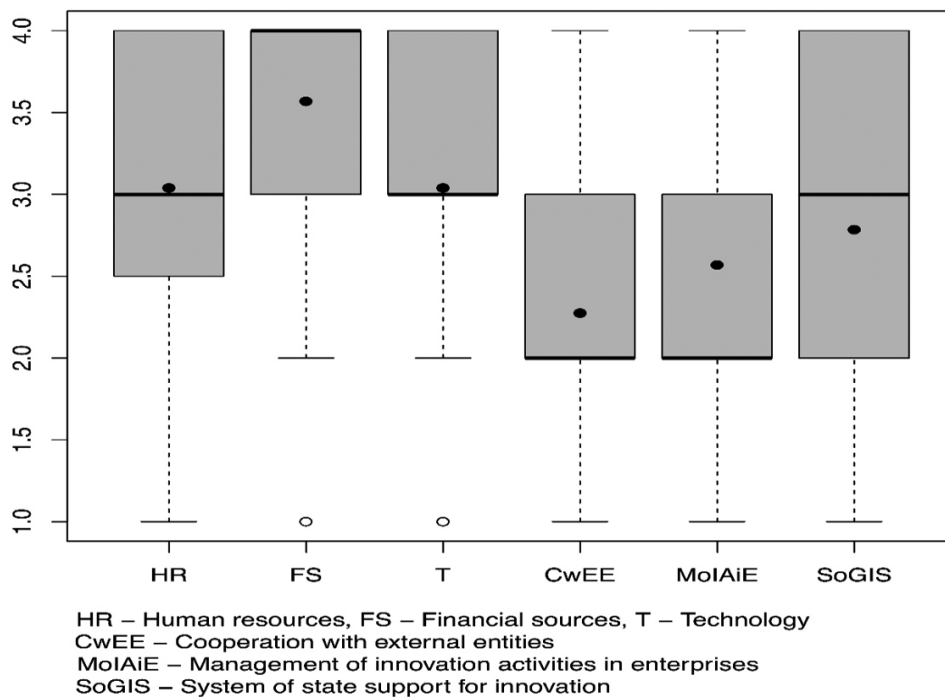
Evaluating the importance of the key factors (Table 3), a majority of enterprises (64.7%) indicated financial resources (average 3.56) as the most important factor for their innovations. Another two factors – human resources and technology – had the same average (3.03), but 20 en-

terprises (39.2%) indicated human resources as the most important factor of innovation activity in the enterprise. Technology as the most important factor was indicated by 15 enterprises (29.4%). Critical is the finding that 35 enterprises (68.6%) consider cooperation with external partners as a factor of low importance.

To compare the significance of individual factors determining innovation activities in Slovak SMEs, we used a graphical presentation by box plots. Graph 1 shows that

Table 3: Factors determining innovation activities in Slovak SMEs

Factors	The importance of factors				
	The lowest (1)	Lower (2)	Higher (3)	The Highest (4)	Average
Human resources	5 (9.80%)	8 (15.69%)	18 (35.29%)	20 (39.22%)	3.03
Financial sources	1 (1.96%)	2 (3.92%)	15 (29.41%)	33 (64.71%)	3.56
Technology	3 (5.88%)	7 (13.73%)	26 (50.98%)	15 (29.41%)	3.03
Cooperation with external entities	10 (19.61%)	25 (49.02%)	8 (15.69%)	8 (15.69%)	2.27
Management of innovation activities in enterprises	4 (7.84%)	24 (47.06%)	13 (25.49%)	10 (19.61%)	2.56
System of state support for innovation	7 (13.73%)	14 (27.45%)	13 (25.49%)	17 (33.33%)	2.78



Graph 1: Box plots of factors affecting innovation activities in Slovak SMEs

the median and mean are the highest for financial sources, which suggests that financial sources are the factor with the highest impact on innovation activities in Slovak SMEs.

To answer the first research question (Q1) it can be stated, that there is no statistically significant difference in individual (analysed) factors between innovation leaders and non-innovators and between innovation leaders and followers. It means that managers of enterprises have the same view of the importance of the factors regardless of the introduced innovations.

We evaluated also the significance of individual factors determining innovation activities in all three categories of enterprises (Table 4).

Our research confirmed that in all three categories of enterprises (innovation leaders, non-innovators and modest innovators), financial resources are viewed as the most significant factor in innovation activities.

### *Barriers to innovations in Slovak SMEs*

We defined a checklist of 11 barriers (Table 5) and asked the managers to evaluate the significance of these barriers. The list of 11 barriers was elaborated on the basis of the results from our previous research (Lesáková, et al., 2016; Nemeč, 2014). We assumed that Slovak SMEs do not evaluate the barriers to innovations as equally significant, and to verify this premise, we used the Friedman test. The test

rejected null hypothesis that that none of the barriers is seen by Slovak SMEs as more or less important than the others ( $p\text{-value} < 2.2e-16$ ) and supports our assumption. Table 5 below presents a comparison of the average of individual barriers, standard deviation and median.

Among the most significant barriers were bureaucracy (3.34) – 29 enterprises (57%) evaluated this barrier as the most serious – then, corruption and state support of innovation activities, which achieved the same average (3.14). 25 enterprises (49%) considered these two barriers very significant. Inappropriate system of state support for innovation activities was marked as a serious barrier by 23 enterprises (45%). On the other hand, lack of cooperation with external entities was marked as the least significant barrier (mean = 1.96).

In the next step, we analysed the differences in evaluation of the main barriers to innovation in the three categories of enterprises – innovation leaders, innovation followers and non-innovative enterprises (Table 6).

There is no statistically significant difference in indicating the main barriers between the three categories of enterprises. The results gained from Fisher exact test ( $p\text{-value} = 0.11$ ) indicated only a small difference in corruption. They confirmed a statistically significant difference between the leading enterprises and modest innovators (innovation followers) in evaluating the corruption barrier ( $p\text{-value} = 0.076$ ).

*Table 4: Evaluating factors determining innovation activities in three categories of SMEs by importance on scale 1 – 4 (4 means the highest importance and 1 the lowest importance)*

Factors	All enterprises		Leaders		Modest innovators		Non-innovative SMEs	
	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)
Human resources	3.04 (0.98)	3.0 (1.5)	3.46 (0.66)	4.0 (1.0)	2.79 (1.02)	3.0 (2.0)	3.07 (1.07)	3.0 (1.0)
Financial sources	3.57 (0.67)	4.0 (1.0)	3.54 (0.66)	4.0 (1.0)	3.50 (0.78)	4.0 (1.0)	3.71 (0.47)	4.0 (0.8)
Technology	3.04 (0.82)	3.0 (1.0)	3.23 (0.73)	3.0 (1.0)	2.75 (0.79)	3.0 (1.0)	3.36 (0.84)	3.5 (1.0)
Cooperation with external entities	2.27 (0.96)	2.0 (1.0)	2.62 (1.04)	3.0 (1.0)	2.17 (0.96)	2.0 (0.0)	2.14 (0.86)	2.0 (0.8)
Management of innovation activities in enterprises	2.57 (0.90)	2.0 (1.0)	2.69 (0.95)	3.0 (1.0)	2.50 (0.93)	2.0 (1.0)	2.57 (0.85)	2.5 (1.0)
System of state support for innovation	2.78 (1.06)	3.0 (2.0)	3.23 (1.01)	4.0 (1.0)	2.42 (1.02)	2.0 (1.0)	3.00 (1.04)	3.0 (1.0)

Table 5: Barriers to innovations in Slovak SMEs by importance on scale 1 – 4 (4 means the highest importance and 1 the lowest importance)

Barriers	All enterprises	
	Mean (SD)	Median (IQR)
Bureaucracy	3.34 (0.92)	4.00 (1.00)
Corruption	3.14 (1.03)	3.50 (1.75)
Inappropriate system of state support for innovation	3.14 (0.99)	3.00 (1.00)
High costs for innovations	2.98 (0.72)	3.00 (0.00)
Lack of internal financial sources	2.82 (0.97)	3.00 (1.00)
Difficulty in obtaining of external financial sources	2.80 (1.04)	3.00 (2.00)
Insufficiently qualified labour force	2.35 (1.05)	2.00 (2.00)
Lack of knowledge about benefits of R&D in enterprise	2.00 (0.96)	2.00 (2.00)
Lack of willingness to innovate	1.98 (0.98)	2.00 (2.00)
Absence of innovation strategy	1.98 (0.97)	2.00 (1.00)
Lack of cooperation with external entities	1.96 (0.98)	2.00 (1.00)

Table 6: Barriers to innovations in Slovak SMEs according to three categories of enterprises

Barriers	Leaders		Modest innovators		Non-innovative SMEs	
	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)
Bureaucracy	3.75 (0.62)	4.00 (0.00)	3.13 (0.99)	3.00 (1.25)	3.36 (0.93)	4.00 (1.00)
Corruption	3.75 (0.62)	4.00 (0.00)	2.88 (1.08)	3.00 (2.00)	3.07 (1.07)	3.00 (1.00)
Inappropriate system of state support for innovation	3.58 (0.67)	4.00 (1.00)	2.79 (1.06)	3.00 (2.00)	3.36 (0.93)	4.00 (1.00)
High cost for innovations	2.92 (0.79)	3.00 (1.25)	2.96 (0.75)	3.00 (0.00)	3.08 (0.64)	3.00 (0.00)
Lack of internal financial sources	2.75 (1.14)	3.00 (0.75)	2.79 (0.93)	3.00 (1.00)	2.92 (0.95)	3.00 (2.00)
Difficulty in obtaining of external financial sources	2.83 (1.11)	3.00 (2.00)	2.70 (1.11)	2.00 (2.00)	2.93 (0.92)	3.00 (1.50)
Insufficiently qualified labour force	2.58 (1.16)	3.00 (1.50)	2.25 (0.94)	2.00 (1.25)	2.31 (1.18)	2.00 (2.00)
Lack of knowledge about benefits of R&D in enterprise	1.62 (0.96)	1.00 (1.00)	2.21 (0.98)	2.00 (2.00)	2.00 (0.85)	2.00 (2.00)
Lack of willingness to innovate	2.15 (0.99)	2.00 (2.00)	1.92 (1.02)	2.00 (2.00)	1.92 (0.95)	2.00 (1.00)
Absence of innovation strategy	2.15 (1.07)	2.00 (2.00)	1.92 (0.88)	2.00 (1.25)	1.92 (1.08)	2.00 (1.00)
Lack of cooperation with external entities	2.25 (1.22)	2.00 (2.25)	1.96 (0.91)	2.00 (1.00)	1.69 (0.85)	1.00 (1.00)

Results of statistical analysis enable to answer the second research question (Q2). Innovation leaders indicated bureaucracy (mean = 3.75) and corruption (mean = 3.75) as the most significant barrier and state support of innovation activities as a significant barrier (mean = 3.58). Bureaucracy and corruption were marked as significant barriers also by modest innovators (mean = 3.13). High cost of innovations was a significant barrier for innovation followers. Inappropriate state support of innovation activities is another significant barrier, especially for non-innovative SMEs (mean = 3.36).

It can be concluded that a majority of enterprises see the main barriers to developing innovation activities in: 1. bureaucracy and corruption, 2. inappropriate state support of innovation activities, 3. high cost of innovation and 4. lack of financial resources.

Based on the test results, and the fact that our sample size was sufficiently large to identify large and medium differences between the sample and the population with respect to chosen criteria, as well as large and medium effect sizes, we concluded that our sample of enterprises can be seen as a reasonable sample of the entire population of small and medium enterprises.

## 5 Discussion and conclusion

Research results confirmed that managers of all three categories of enterprises have the same or a very similar opinion on the significance of the factors and barriers, regardless of the type and number of innovations. No statistically significant difference was confirmed here.

In the following part, we will briefly conclude the results of the research aimed at identification of key factors and barriers of innovation activities in Slovak SMEs. The main implications are basic recommendations for state policy makers as well as SMEs' managers to foster innovation activities in enterprises. We can summarise them as follows:

1. Innovation leaders, modest innovators and non-innovative firms see **financial resources** as the most significant factor for innovation activities (see Table 4). For the future, it will be necessary to mobilise all financial sources in the area of innovation support in order to ensure that innovation activities performed by business entities receive the same level of funding as those in advanced EU countries. In connection with the efforts towards the most effective use of allocated financial resources, the state will have to provide indirect aid to profit-generating projects implemented by SMEs, i.e. it will have to use financial engineering instruments such as guarantee funds, credit funds, venture capital funds and municipal development funds. There is an enormous interest of competent institutions in coordination with the Ministry of Finance of the Slovak Republic to apply an upgraded

model of usage of innovative financial tools in order to support innovation activities in SMEs (Country Report Slovakia, 2016). Slovakia has set a target to increase expenditures on research and development to 1.2% of GDP by 2020. To support the financing of innovations, the situation should be changed not only by one way financial support from state budget, but also by increasing the resources of businesses, which in 2020, should account for 2/3 of the total resources spent on R&D. This implies much greater involvement of SMEs in research. The state should adopt measures that would encourage businesses to be much more engaged in research, development and innovation. We see a solution also in overall improvement of the business environment, for example, through a reduction of indirect taxes – especially VAT rate, reduction of contributions to social and health insurance companies, and in all the other areas mentioned above.

2. **High-quality human resources** were indicated as an important prerequisite for developing innovation activity (see Table 3). The results showed a small difference between innovation leaders and non-innovators (see Table 4). Quality management and employees able to think creatively and implement innovations in their activity are crucial to the development of innovation activity of an enterprise. The management must be able to lead and direct the thoughts and ideas in the enterprise, search and use talents, and must be also aware of the fact that the enterprise will be successful due to being distinguished by the human resources (Frappaolo, 2006). The demand for creative workers should motivate Slovak secondary schools and universities to equip their students with such competencies that would accommodate their future employers. Each business subject should be more actively involved in the educational process (Janson, Cecez-Kecmanovic, & Zupančič, 2007). A solution to this problem could be “dual educational system”, which has been recently launched in Slovak secondary vocational schools. Firms could also give more support to lifelong learning of their employees to improve their qualifications and skills needed for the implementation of innovative actions. These educational activities should be carried out in cooperation with cluster organizations, industrial chambers and associations operating in Slovakia, as well as regional authorities and municipalities. Employees are expected to have a pro-active approach and to be willing to learn and implement new knowledge in the innovation activity. On the other hand, they must be adequately rewarded for their innovation ideas, for their increased effort to search for new, innovative solutions (Lesáková, 2009).



3. Another factor significant for the development of innovation activity is **cooperation and participation of SMEs in different networks and clusters** (on scale 1-4 where 4 means the highest importance and 1 means the lowest importance means was 2.27). It is surprising that for 49.0% of the responded enterprises, cooperation with external entities in innovations has a lower importance (see Table 3). Modest innovators reported a significantly lower level of cooperation (mean = 2.17). The positive examples from EU countries confirm that participation of small and medium enterprises in networks and clusters and support of partnerships is a way to involve small and medium enterprises in innovation activities (Cygler, Gajdzik, & Sroka, 2014). Innovation process of a higher level calls for improvement of interaction between small and medium enterprises, research institutions and universities and for creation of effective networks and partnerships (Lesáková, 2009). Creating a partnership is a way to get involved in innovation activities. Cooperation of SMEs with other organisations in the field of innovation activities brings several synergic effects to the enterprise. The most important of them is sharing of knowledge and a similar approach to the latest know-how, sharing of capacities, a lower demand for financial sources, etc. Support to innovative industrial cluster organisations is also one of the main measures in the Innovation Strategy of the Slovak Republic for the years 2014 – 2020. The purpose is to improve the competitiveness of these organisations through support of their selected activities with a view to promote joint industrial activities in selected areas (Innovation Strategy of the SR for 2014 – 2020).

4. According to the research results, the government should pay much more attention to **systematic institutional support to SMEs** on the national and regional level (see Table 4). All enterprises (innovation leaders, modest innovators and non-innovators) pointed to the low quality of innovation support. Inappropriate state support of innovation activities is a significant barrier (see Table 5), especially for non-innovative enterprises (see Table 6, mean = 3.36). Of special importance is the development of institutions supporting innovation activities on the national and regional level. Setting up regional innovation centres would foster implementation of the regional and state innovation policy in regions and thus increase the competitiveness and employment at the regional level and reduce regional disparities. Regional innovation centres could help to start cooperation between SMEs on the one hand, and universities and research centres on the other hand. A critical point is autonomous functioning of sectors of education, research and innovation (R&I) and business, which

means a different understanding of R&I. It is necessary to create links between R&I in multinational companies and in local businesses, including SMEs, and to increase the interest of businesses and industrial clusters to change the structure of industrial R&I entities. Successful implementation of the innovation strategy requires a structural change of the competencies of the management of research and innovation in Slovakia and a fundamental change in the culture of innovative environment.

5. SMEs' managers agreed on the fact that without a **well-created vision and clearly formulated aims**, innovation activity in SMEs is limited. The results showed that the management of innovation is a part of the business strategy in the category of innovation leaders (46% – 94%), but it is not the case of many modest innovators and non-innovators. Clearly formulated objectives are a vision depending on the possibilities of the enterprise and the situation in the market. Clear vision is a strong predictor of success (Wagner, & Hollenbeck, 2012).
6. And the last precondition that appeared in the answers of managers is **willingness of enterprises to innovate**. This is an inevitable factor, even if it is connected with a certain risk. The positive thing is that “lack of willingness to innovate” had the lowest rank in all three categories of enterprises (see Table 6). Many innovative SMEs now are successful and perspective and, on the contrary, many enterprises without innovative activity are getting into financial problems. Willingness to innovate should be accompanied by such an environment that will support the rise of innovation activities (Lesáková, 2013). In this way, innovations could be introduced faster and at the same time, the number of barriers retarding the rise of innovation activities could be lower.

The low number of innovative enterprises in Slovakia is a result of **innovation barriers** that are an obstacle hampering successful development of innovation activities in businesses. Specifically, Slovak enterprises suffer from a lack of financial sources to innovation, which significantly reduces their innovation activity; yet, the major obstacle lies in bureaucracy and corruption.

The explanation why bureaucracy and corruption are viewed by Slovak SMEs as the main barriers (see Table 5) comes from their experience during the process of raising money and developing innovation activities. The enterprises mentioned their negative experience with obtaining finance from the European Union funds or other public financial sources (bureaucratic administration, corruption, ineffective redistribution of finances, as well as ignorance of their drawing).

High cost of innovation was also appeared on the list of significant barriers to innovation for Slovak SMEs. Never-

theless, managers should take into consideration that innovation is a prerequisite to get a competitive advantage in future.

The respondents expressed a critical opinion about the institutional form of support from the state (see Table 5) – about the existence and activities of institutions supporting innovation activities as well as the support of the rise and development of innovative SMEs. Critically are also viewed Slovak regional offices in terms of the missing regional innovation structures; there is no scheme for effective management of the state innovation policy and regional innovation strategies. The respondents were critical to the long-term absence of regional innovation centres, which should help to start cooperation between SMEs on the one hand, and universities, research centres, technological parks on the other hand, and to enhance the process of establishing clusters.

Some of the barriers can be eliminated at the level of enterprise, but most of them require solutions at the state level. Therefore, the task for the state is to ensure adequate inputs (sources) for innovation activities and create suitable conditions, i.e. an environment that can stimulate development of innovation.

Our research is a scan of the current situation of identification key factors and barriers determining innovation activities in Slovak SMEs and offers a lot of space to improve. The biggest limitations of this study is a small response rate of the questionnaire which prevented us from taking our statistical analyses further. Consequently, the presented results should be interpreted primarily from the exploratory point of view. Limitations of our study create opportunities for future research. In the future we plan to focus on higher number of enterprises, including enterprises of various size (small, medium-sized and large enterprises) and also from various countries. It would be very interesting to repeat our primary research in other countries than Slovakia for the purpose of making international comparison of identification (evaluation) of key factors and barriers determining innovation activities in SMEs.

## Acknowledgement

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## **Inovacijski vodje, skromni inovatorji in neinovativna mala in srednje velika podjetja na Slovaškem: ključni dejavniki in ovire pri inovacijskih dejavnostih**

**Ozadje in namen:** Področje inovacij predstavlja temeljni izziv za mala in srednje velika podjetja (MSP). Da bi lahko povečali število inovativnih MSP, moramo opredeliti ključne dejavnike, ki določajo njihovo inovacijsko dejavnost in odpravijo inovacijske ovire. Glavni namen prispevka je predstaviti rezultate raziskave, osredotočene na identifikacijo in oceno ključnih dejavnikov in ovir inovacijske dejavnosti v MSP. Ta podjetja smo klasificirali v tri skupine: inovacijski voditelji, skromni inovatorji in neinovatorji, kar omogoča prepoznati razlike v mnenjih menedžerjev o glavnih dejavnikih in ovirah, ki vplivajo na inovacijske dejavnosti v različnih vrstah malih in srednje velikih podjetij, in oblikovati smernice posledice za slovaška MSP.

**Zasnova / metodologija / pristop:** Zbrane empirične podatke smo obdelali z MS Excel in s statističnim paketom R3.2.4. Pri statističnih testih smo privzeli raven pomembnosti ( $\alpha = 0,1$ ).

**Rezultati:** Večina podjetij (64,71%) je kot najpomembnejši dejavnik inovativnosti navedla finančna sredstva. Med (analiziranimi) posameznimi dejavniki med inovativnimi voditelji, skromnimi inovatorji in neinovatorji nismo ugotovili statistično značilnih razlik. Rezultati, pridobljeni s Fisherjevim testom ( $p$ -vrednost = 0.11), kažejo majhno razliko pri vrednotenju pomena posameznih ovir med vodilnimi inovatorji, neinovatorji in skromnimi inovatorji. Večina podjetij meni, da so nadaljnje glavne ovire pri birokracija in korupcija na področju inovacijskih dejavnosti ter neustrezna državna podpora inovacijskim dejavnostim.

**Zaključek:** Iz raziskave izhajajo osnovna priporočila za snovalce državnih politik, pa tudi za mala in srednja podjetja, da spodbujajo inovacijske dejavnosti v podjetjih. Nanašajo se na področje finančnih virov, visokokakovostnih človeških virov, sodelovanje in udeležbo MSP v različnih omrežjih in grozdih, sistematično institucionalna podpora MSP, dobro oblikovano vizija in jasno oblikovane cilje in pripravljenost podjetij na inovacije.

**Ključne besede:** *inovacije; mala in srednje velika podjetja; dejavniki; ovire; Slovaška republika*

## Appendix

Listed below are only the questions relevant to theme of the article.

*Q1: Which type of innovations did you introduce in each year of the analysed period?*

	2015	2014	2013	2012	2011	2010
Product innovations						
Process innovations						
Organizational innovations						
Marketing innovations						

*Q2: Evaluate the importance of the key factors determining innovation activities.*

Factors	The importance of factors			
	The lowest (1)	Lower (2)	Higher (3)	The highest (4)
Human resources				
Financial sources				
Technology				
Cooperation with external entities				
Management of innovation activities in enterprises				
System of state support for innovation				

*Q3: Evaluate the importance of barriers to innovations.*

Barriers	The importance of barriers			
	The lowest (1)	Lower (2)	Higher (3)	The highest (4)
Lack of internal financial sources				
Difficulty in obtaining of external financial sources				
High costs for innovations				
Insufficiently qualified labour force				
Lack of willingness to innovate				
Absence of innovation strategy				
Lack of cooperation with external entities				
Inappropriate system of state support for innovation				
Bureaucracy				
Corruption				
Lack of knowledge about benefits of R&D in enterprise				



*Q 4: Evaluate motives to realize the innovation activities (5 = the most important motive, 1 = the less important motive).*

	Growing competition at the market
	The effort to keep the customer at the market
	The innovation impulse coming from employees
	The effort to enter on new (foreign) markets
	Changes in the legislative requirements
	Possibility to cooperate with another company, resp. institutions
	The innovation impulse coming from owner of
	Possibility to gain the financial as well as non-financial support from the state or from the EU

*Q 28: What is the number of SK NACE of your enterprises?*

*Q 29: Indicate the region where your enterprises is located.*

- Bratislava region
- Trnava region
- Trenčín region
- Nitra region
- Banská Bystrica region
- Žilina region
- Prešov region
- Košice region

*Q 30: Indicate the number of employees in your enterprises.*

- 0 - 9 employees (micro enterprises)
- 10 - 49 employees (small enterprises)
- 50 - 249 employees (medium enterprises)
- 250 employees and more (big enterprises)

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# The Use of the Kano Model to Enhance Customer Satisfaction

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**Background/purpose:** The interest of measuring customer satisfaction is reflected in its ability to gain customer loyalty, enhance favourable word of mouth, lead to repeat purchases and improve a company's market share and profitability. The issue of integrating the Kano model of customer satisfaction with other models and tools to support development or improvement of a product, or to determine market strategies, is relatively unexplored in the Slovenian sector. This research aims to construct the Kano model in order to enhance customer satisfaction in the case of home appliances.

**Design/Methodology/Approach:** Data was collected using an online survey amongst randomly selected individuals from the service interventions for an end users database. Principal component factor analysis was first used to identify the underlying factors of home appliance characteristics. In the next phase we calculated the derived and stated importance of customer satisfaction, which was then used to construct the Kano model of customer satisfaction. We further analysed which factors are the strongest drivers, or predictors, of repeat purchase using multiple regression analysis.

**Results:** In the study we identified the underlying home appliance factors. The results show that these factors are: sales environment, price, user features, design features and technical features. The results were then used to construct the Kano model where the analysis goes beyond the qualitative analysis by implementing two approaches, stated and derived importance approach. According to the Kano model, marketers should concentrate on delight characteristics such as: wider knowledge of the salesperson, professional skills of the salesperson, design of home appliance, brand of home appliance. What is more, factors called 'user features' are the strongest predictors of repeat purchase.

**Conclusion:** This paper links the Kano model with measuring customer satisfaction and presents a contribution for marketing research theory. Therefore, the results could be used to support optimization of business decision-making, as well as for further scientific research.

**Keywords:** *optimization; business decisions; Kano model; measuring customer satisfaction*

## 1 Introduction

Business decisions related to the market demand some ability to track and predict the behaviour of large groups of people. How can one predict only one person's decisions? If we go further, how can one predict the behaviour of many people? The effective approach can be expected through efficiently gathering data and connecting this data with statistical analyses. The procedures and methodolo-

gy of marketing research make it feasible to gather usable information, based on which we can make strategic decisions. The risk of incorrect decisions can also be lowered.

The purpose of market research is to gather information that can be used to identify opportunities, as well as problems, in marketing and to choose more effective actions in the marketplace. Marketing research uses information from all sources connected with marketing (company, competition, marketing mix, social and technological

environment), whereas market research gathers, edits and analyse data for a certain market or segment (see, for example Macdonald, Wilson & Konuş, 2012).

The purpose of market research is to link the customer to the marketer by providing information that can be used in making marketing decisions. Some believe that the link between the customer and market research is more important today than ever. Competition for the customer is growing every day, customers expect greater value. Companies have to learn insights from customers in order to keep them loyal (Burns & Bush, 2010). One way for companies to get insights from customers is to measure customer satisfaction (Šuster Erjavec et al., 2016). Customer opinions are often sought in the form of surveys asking questions about perceptions of quality, experiences with a brand or purchase, with the likelihood to come back and buy again or tell friends about their experience.

We are interested in the extent to which customers are satisfied or dissatisfied with home appliance product characteristics. One of the models to measure customer satisfaction is the Kano model of customer satisfaction (discussion on the Kano model is provided in subsection 3.1) which classifies product characteristics based on how they are perceived by customers and their effect on customer satisfaction. The theory of attractive quality offers insight into the dynamics of product and service attributes. This theory of attractive quality also deals with the relationship between the objective performance of attribute and customer satisfaction with attribute. According to the nature of this relationship, attributes are classified into one of five quality dimensions: attractive quality, one-dimensional quality, must-be quality, indifferent quality and reverse quality (see, for example Taifa & Desai, 2017; Fonseca, 2015; Nilsson-Witell & Fundin, 2005). There have been several applications of the Kano model, as well as adaptations of the Kano model. Dominici et al. (2016) apply the Kano model to find the drivers for achieving customer satisfaction with new product developments in smartcars exploiting the value potential of internet of things technologies. Being aware of reducing pollution emissions, more companies have started to focus on clean energy as well. Yang et al. (2015) use the Kano model to analyse customer needs for the battery electric vehicle in order to promote the adoption of such vehicles in Shanghai. Authors use four approaches to categorize the battery electric vehicle attributes as must-be quality, one-dimensional quality, attractive quality and indifferent quality. Furthermore, Shahin et al. (2017) provide revision of the Kano model and separating indifference attributes in order to develop satisfaction and dissatisfaction indexes and to apply such a newly defined Kano model in the presidential election, whereas Chang & Chen (2014) apply the Kano model with a modified customer satisfaction coefficient to reach effectiveness for a semiconductor wafer fabrication. Additionally, an adapted approach to the Kano model to identify patient needs

from different patient roles can be found in Gustavsson et al. (2016). Authors report that such an approach to viewing patients as customers and incorporating inputs from various groups and various stakeholders appear to help in the identification of a wide range of patient needs. In their study, Murali, Pugazhendhi & Muralidharan (2016) demonstrated the application of multiple regression analysis in studying the influence of after sales services attributes on customer satisfaction, customer loyalty and customer retention for three different products from the home appliances sector and based on the results, suitable strategies can be developed to improve customer satisfaction, customer loyalty and customer retention. The paper aims to help companies develop better understanding, as well as to highlight the importance of measuring customer satisfaction. The empirical part of the paper provides a means for companies to integrate the Kano model with other models and tools to support development or improvement of a product, or to determine market strategies in order to add value and to improve company performance.

The paper is structured as follows: after a brief introduction, we present a/the marketing system, we continue with the marketing management process, then present the concept of customer satisfaction and the Kano model. We continue with the empirical application and finally conclude.

## 2 Literature review

### 2.1 Marketing system

Marketing research grew out of the needs and demands of the marketing system. The marketing system represents a conceptual model in which marketing mix and situational factors are seen as independent variables (input) and cause behavioural responses and performance measures (Feinberg et al., 2013; Jobber, 2007) (Figure 1).

Independent variables in marketing research can be separated into situational factors (which cannot be controlled) and various decisions regarding marketing mix made by the organization. The environment to which the selling organization must adopt is represented by situational factors. These factors include availability of resources, actions of competitors, economic climate, market trends and government regulations. Although these cannot be controlled, they can be measured. Alternatively, numerous variables are difficult or impossible to measure, such as customer moods whilst shopping – they must be treated as unobservable. There are numerous other decisions and choices made under the control of the organization. Among the most important of these is marketing mix, which typically includes product, price, places and promotion. Combinations of different levels of these variables form alternative marketing programs or courses of action.

To understand market dynamics and customer behaviour it is realistic to view these as inputs or decision variables (Aaker, 2010; Aaker, 2005; Chernatony, 2002).

Behavioural response is influenced with both independent variables (namely marketing mix and situational factors), which include: purchases, buying intentions, preferences and attitudes. It would not be reasonable to believe that behavioural responses result only from independent variables. Actual behaviour is a combination of a variety of effects – some are controllable, some merely measurable and some unobservable. This on the other hand complicates the question of how to develop a marketing program that effectively handles a dynamic set of variables and behavioural responses (see, for example Burns & Bush, 2010; Aaker, 2010). Behavioural responses form the basis of an organization's monetary and non-monetary performance measures. Monetary measures include: sales, market share, profit, ROI, cash flow. Non-monetary measures, for example, are the organization's image and customer satisfaction, which is further discussed in this paper. In practice, business decisions are rarely driven exclusively by these input-output marketing models and formal statistical models. Rather they are a combination of managerial experience, judgement and intuition (Feinberg et al., 2013).

## 2.2 Marketing management process

The main task of marketing management is to comprehend the marketing system well enough to make decisions that affect that system in accordance with the organization's goals (Feinberg et al., 2013). The role of the informational feedback between the marketing system and the deci-

sion-making process, which is called marketing management process, is shown in Figure 2.

The decisions made by managers are aimed at influencing the performance measure in a predictable manner, based on information concerning the/a/their marketing system (see, for example Johansson et al., 2014; Strandskov, 2006). They are informed by past experiences and marketing research and can thus plan future actions by comparing performance against objectives (Aaker & Joachimsthaler, 2009).

## 2.3 Measuring customer satisfaction

We already mentioned that performance measures in marketing system are those which managers try to influence and can be divided into monetary and non-monetary performance measures. One of the non-monetary performance measures is customer satisfaction, which is further discussed in this paper. Customer satisfaction represents one of the key concepts in modern marketing theory and practice. Each company is trying to satisfy its customers in a way, that customers would repeatedly come back. Each company is striving for long-term customer loyalty (see, for example Gričar & Bojnec, 2013; Ažman & Gomišček, 2012; Čočkaló, Đorđević & Sajfert, 2011; Almquist, Senior & Bloch, 2016). In preliminary research involving the measurement of customer satisfaction, it was found that customer satisfaction was not only influenced by perceived product quality, but also by the whole shopping experience and expectations (Wen Wu, 2006). From that point, customer satisfaction has been defined in different ways and contexts. According to the literature review, we could define two different conceptualizations of customer

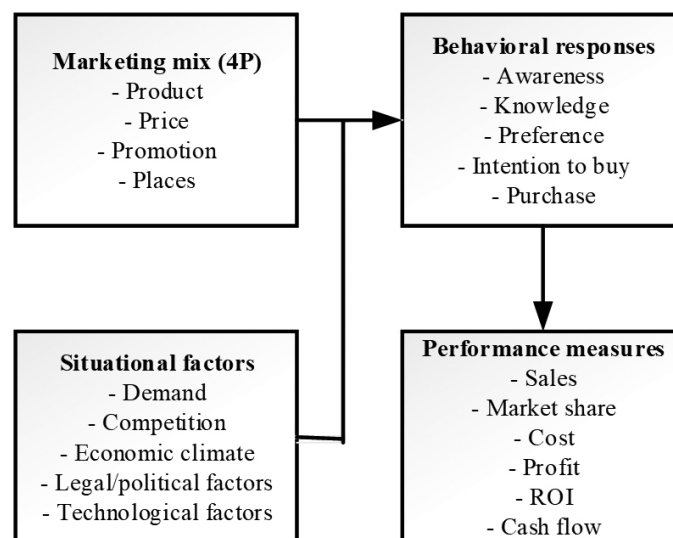


Figure 1: Model of the marketing system

satisfaction. Firstly, satisfaction is an effective construct based on feelings and emotions. Secondly, satisfaction is a dynamic construct that develops over a period of time. These two different conceptualizations are also called transaction-specific and cumulative satisfaction respectively (see, for example Anderson et al., 1994; Burns & Bush, 2010). According to (Gronholdt et al., 2000; Kobylanski & Pawlowska, 2012; O'Sullivan & McCallig, 2012) satisfaction is the customer's emotional and rational (cognitive) evaluation of experiences with a product or service. The standards that customers are using to evaluate their experiences are the basis for their judgement of fulfilment of promises. These could be personal goals, needs, expectations and experiences with competitive companies. Customer satisfaction has to be seen as one of the main goals of a company's managers and therefore the source of a competitive advantage. It is actually an investment which brings measurable business benefits. In such a manner it is reasonable to manage customer satisfaction and to monitor factors which influence business benefits that satisfaction brings. Influence on the successfulness of a company is namely derived from the following direct benefits which come from satisfaction: higher consumption, higher level of loyalty, willingness to pay more, greater expectations, lower costs, good reputation and positive word of mouth. Additionally, satisfaction also influences financial successfulness of a company. There are numerous studies that confirmed positive effect of satisfaction on return on investment and profitability of a company (see, for example Anderson et al., 1994; Omachonu et al., 2008;

Yeung & Ennew, 2000; Yu, 2007). The strategic meaning of satisfaction besides business benefits is also seen in how satisfaction represents such elements according to which basic business strategy has to be determined. In such a way, a company can follow strategy of specialisation, focusing on narrow, specific market segments ensuring high quality. Such a strategy leads to the above-average satisfaction, greater loyalty and higher price premiums. Second basic business strategy can be mass, undifferentiated strategy, where »average«, price sensitive customers are targeted. Somewhat lower satisfaction is acceptable with this strategy as companies are competing with lower costs or prices rather than with quality or differentiated supply. What is more, customers within the second strategy have increasingly greater expectations so the threshold of yet acceptable satisfaction is increasingly greater for them.

One of the models to measure customer satisfaction is the Kano model of customer satisfaction which classifies product attributes based on how they are perceived by customers and their effect on customer satisfaction (Chu, 2002; Di Paula, 1999; Grigoroudis & Spyridaki, 2003; Kano et al., 1984; Lilien et al., 1992; Južnik Rotar & Kozar, 2012). These classifications are useful for guiding design decisions – they indicate when good is good enough and when more is better (Kano Model Analysis, 2014; Spool, 2011).

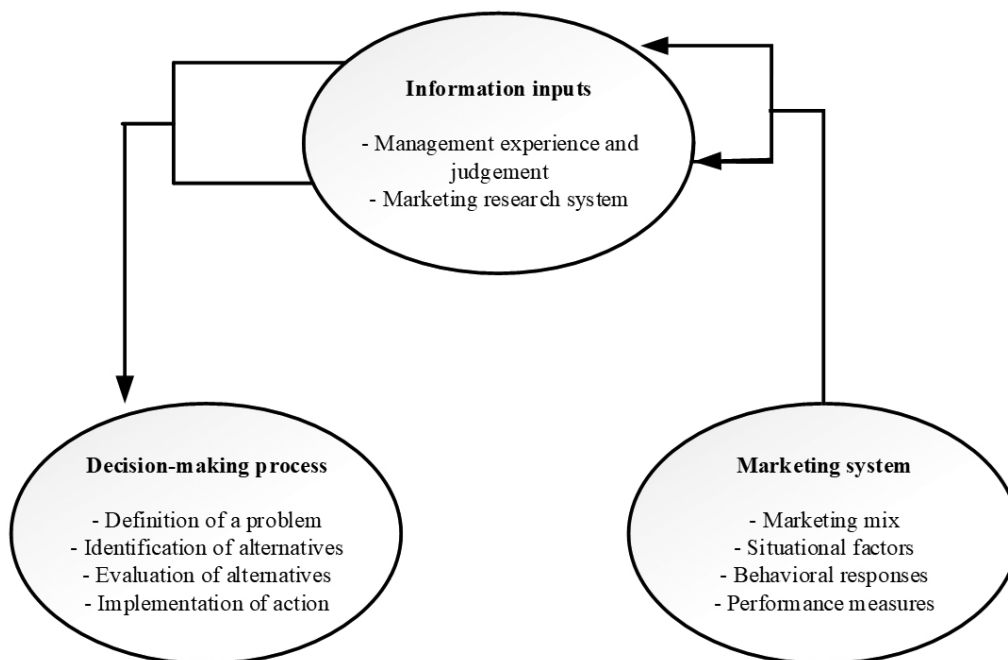


Figure 2: Marketing management process



### 3 The Kano model of customer satisfaction

#### 3.4 Short overview of the Kano model of customer satisfaction

The Kano model of customer satisfaction, proposed by the Japanese professor Noriaki Kano and his colleagues, divides product attributes into three categories: threshold or must be, performance and excitement or delighter (see Figure 3). A competitive product meets basic attributes, maximizes performance attributes and includes as many excitement attributes as possible (Chen & Chuang, 2008; Kano Model Analysis, 2014; Kano et al., 1984; Spool, 2011). The Kano model is used to determine the customer expectations regarding product – it is used for analyzing customer needs and determining product requirements. The main focus of customer needs abbreviates from the product quality properties. Customers (or potential customers) are trying to solve an issue or realize an opportunity. However, it is crucial to define a segregation of needs, since we know all the needs are not equal – different customers have different priorities and meanings attached to their needs.

##### 3.5.5 History

The Kano model was developed in 1984 by Noriaki Kano and his team. It was formulated to define a model that could categorize and prioritize customer needs and provide the manufacturer with guidelines for product development lifecycle and to provide the customer with on-growing satisfaction when returning for the new line of a product from the same manufacturer.

##### 3.1.2 The model

The model itself can be shown graphically as a combination of two axis – the  $x$  axis and the  $y$  axis, where the  $x$  axis defines whether the customer needs were met and to what extent (the  $x$  axis can be understood as the products performance or function) and the  $y$  axis is the level of customer response to the product: was the customer delighted or disappointed. The customer response and the level of meeting expectations is divided into three categories (see, for example Chen & Chuang, 2008):

- *Basic needs* or as we can call them the “must be requirements”. The requirements in this category are essential – if they are met it means that there is no special delight for the customer, they are performing quite neutral. But if these requirements are not met, the customers are disappointed and the product is not likely to be sold.
- *Performance needs*. These are needs that the custom-

er can define and the manufacturer can discuss. The needs are subject to the “more is better” rule. The needs that are met here are the one that separate one product or service from another. This is the category which provides the separation between competitors. In this category the product or service provides an answer to questions such as: What is the level of service? What is the price performance? What features does a product have?

- *Attractive (delight) needs*. These are mostly the unspoken needs that the customer cannot define. These needs are not expected by the customer – so if the product or the service does not provide them, the customers are neutral, since they were not expecting them in the first place. But if the product or service provides them, the customers are excited.

These three categories can be used for defining our product or service requirements and design. When designing a new product, it is expected that all the requirements from the first category are met – there can be no option to omit them. When taking the second category (performance needs) into focus, it is clear that in this category the product or service and its place between competitors is defined. This is where the right level of features and properties are defined to assure an attractive and competitive product. The third category is where the “wow” effect is defined. Each product or service should have at least one or two such features which delight the customer and therefore provide the final differentiation of the product from the competition. By integrating such features into our product or service, this really means embellishing the product or service when we are defining it.

##### 3.1.3 Use of the Kano model

The Kano model can be used in different ways, depending on the matter in focus. However, it is crucial to always provide the three category view of the customer regarding the matter in focus. Once it can be used as a model for meeting the features and properties that the product should have, it can be used as a model for defining and benchmarking the product basic quality against other products on the market. The Kano model is sometimes called the ‘two-dimensional quality model’.

The customer sees the Kano model as a simple classification of the products they encounter – they see them as basic, good or excellent products. This is where use of the Kano model becomes complex. When providing a solution to a global market, sometimes the understanding of delight can vary from one location to another, one culture to another, one set of values to another. The second important factor is the definition of delight during the time. As time passes, the sets of features that provide delight changes. So when defining the features and properties from a distance,

it is important to understand the “strategic” in the “operational” usage of the Kano model. The “strategic” point of view suggests something like “our product will have excellent design features”, and the more operative approach says something like “this year our dishwashers shall be made in all the colors of the rainbow.”

If the Kano model is utilized as a tool for defining the products and their quality, the understanding of ‘delight’ and ‘must have’ must be permanently and constantly re-defined (see, for example Butori & De Bruyn, 2013). This definition must be relevant to both the market and time in which the product is meant to meet the market. Through doing this efficiently the Kano model is and can be used as a tool for achieving customer loyalty and a perennial, yet steady, growth of new customers wanting to buy the product.

### 3.6 Stated and derived importance

In order to construct the Kano model, we must define  $x$  axis and  $y$  axis. We define  $x$  axis as stated importance, whereas  $y$  axis is defined as derived importance. In customer satisfaction surveys, the most frequent request is to rate the importance of a particular product or service attribute. This information is used by a company to determine which attributes are valued most by customers and how they are related (Di Paula, 1999; Smith & Wright, 2004). When analysing data from customer satisfaction surveys, a common problem is the comparison of stated and derived importance for a set of satisfaction dimensions (Fontenot et al., 2007; Grigoroudis & Spyridaki, 2003; Moliner et

al., 2007; Tarn, 2004; Trif, 2013). The derived importance analysis includes correlating performance ratings for a specific product or service attribute with broader performance criteria. Such criteria could be the overall customer satisfaction ratings of the company, product or service. The more prominent an attribute correlates with overall customer satisfaction, the more important it is for a company to improve performance on that attribute (Di Paula, 1999; Matzler et al., 1996; McElroy, 1989). One of the key advantages of the derived importance approach is that it makes use of statistical modelling – multiple regression in deriving the relative importance of explanatory variables in explaining the dependent variable. In general, this approach is objective by avoiding human bias; the quality of data is higher. Alternatively, the question is to what extent the regression model predicts the dependent variable as a function of the other explanatory variables. Another problem is the existence of multicollinearity. For example, the three variables that measure quality are correlated amongst themselves. The stated importance approach uses both attribute importance and performance ratings. According to Chu (2002) the main reason for using stated importance is that it entails the face validity of the results. It is also a simple technique to administer. This approach involves both importance and performance measures. On the contrary, this is seen as a disadvantage as the attributes are generally measured twice (repetition) and therefore takes more time for a respondent to fill in the questionnaire. Additionally, the response rate may be lower (see, for example Park, 1998; Partovi, 2007).

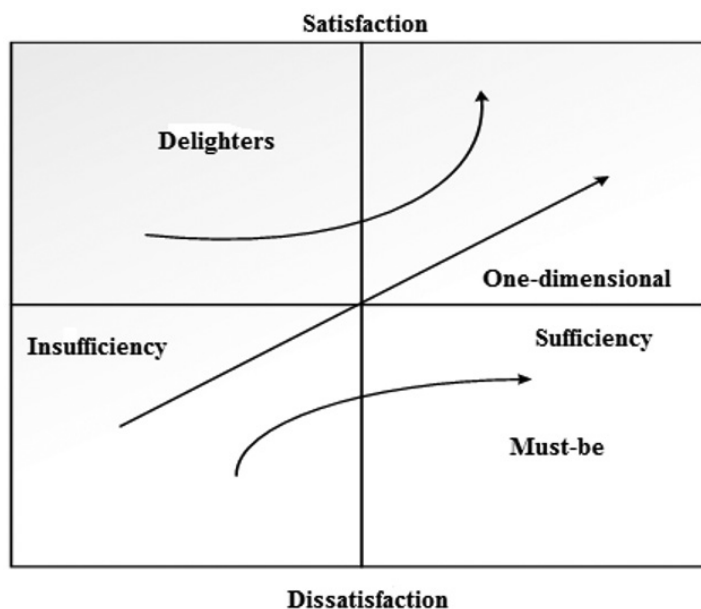


Figure 3: Kano model

## 4 Research methodology

We adopted a quantitative approach regarding data collection and the method used was based on a survey. Respondents were randomly selected individuals from the service interventions for an end users database for which the information of their willingness to participate in such activities was available. Respondents were invited to complete the survey. They received the link to the web application. However, in cases where no email address was available, the paper form of the survey was forwarded. The main part of the survey consisted of 23 home appliance characteristics, which measured respondents' perceived importance and the relative performance of each attribute on a five-point Likert scale. Respondents' overall level of satisfaction with home appliance was also measured on a five-point Likert scale. We obtained 115 valid surveys. Out of 115 valid surveys there were 48,7 % males and 51,3

% females. Approximately half of the respondents were below the age of 40, whereas more than a half of the respondents had a degree from a higher education institution and more. The majority of respondents were employed on a non- fixed terms basis, whereas the mode on income interval was 1000-1499 EUR. The most frequent family size was 4 or 5 members in a family, followed by three and two members in a family.

## 5 Results

We first used factor analysis to identify the underlying factors of the 23 home appliance characteristics. The main objectives of using factor analysis are:

- To create a smaller set of correlated characteristics into dimensions or factors from the existing characteristics that explain the most variance among the characteristics.

Table 1: Descriptive statistics (Source: author calculations)

Characteristics	Label	Mean	Std. dev.
Neatness of salesperson in the workplace	P1	3,10	1,24
Professional skills of salesperson	P2	3,87	1,27
Wider knowledge of salesperson	P3	3,74	1,19
Professional approach of salesperson	P4	3,84	1,29
Appearance of sales salon	P5	3,63	1,18
Appearance of exhibition place where home appliance was presented	P6	3,48	1,19
Web presentation of home appliance	P7	3,74	1,09
Basic price of home appliance	P8	3,93	0,97
Terms of financing and stage payments	P9	3,20	1,33
Discounts and sales campaign	P10	4,00	1,13
More affordable home appliance in comparison to competitive brands	P11	3,20	1,19
Technical features that competing devices do not have	P12	3,67	1,02
Dimensions of home appliance	P13	3,74	1,16
Energy class of home appliance	P14	4,19	0,88
Serially fitted protective equipment	P15	4,03	1,01
Brand of home appliance	P16	3,83	1,04
Colour palette in which home appliance is available	P17	3,30	1,27
Design of home appliance	P18	3,83	1,01
Easy to use	P19	4,23	0,84
Simple basic maintenance of home appliance	P20	4,25	0,94
Guarantee period	P21	4,50	0,81
Service network with available spare parts	P22	4,53	0,74
Keeping in touch with customer after purchase	P23	3,03	1,36

- To apply the derived factors for subsequent analysis: to further calculate the derived importance and stated importance of customer satisfaction which are then used to construct the Kano model of customer satisfaction (due to internal business needs we applied adapted version of the 'original' Kano model where the classification of a feature goes beyond qualitative analysis and is based on stated and the derived impor-

tance approach).

- To analyse which characteristics are the strongest drivers or predictors of repeat purchase.

Principal component factor analysis with varimax rotation was first used to identify the underlying factors of the 23 home appliance characteristics (descriptive statistics is reported in Table 1). The Kaiser-Meyer-Olkin (KMO) meas-

Table 2: Results of factor analysis – identification of underlying home appliance factors (Source: author calculations)

Characteristics	Factor loading				
	Sales environment	Price	User features	Design features	Technical features
<i>Sales environment</i>					
Neatness of salesperson in the workplace	0,83				
Appearance of exhibition place where home appliance was presented	0,81				
Appearance of sales salon	0,78				
Professional skills of salesperson	0,78				
Wider knowledge of salesperson	0,71				
Professional approach of salesperson	0,70				
<i>Price</i>					
Discounts and sales campaign		0,79			
Basic price of home appliance		0,77			
Terms of financing and stage payments		0,71			
More affordable home appliance in comparison to competitive brands		0,69			
<i>User features</i>					
Easy to use			0,72		
Guarantee period			0,71		
Brand of home appliance			0,66		
Simple basic maintenance of home appliance			0,52		
<i>Design features</i>					
Colour palette in which home appliance is available				0,83	
Design of home appliance				0,77	
<i>Technical features</i>					
Energy class of home appliance					0,60
Serially fitted protective equipment					0,58
Dimensions of home appliance					0,51
Eigenvalue	8,29	2,33	1,92	1,42	1,03
% of variance	36,06	10,12	8,37	6,17	4,48
Cronbach's Alpha	0,91	0,80	0,77	0,84	0,71

ure of sampling adequacy was calculated to examine the appropriateness of factor analysis. In our case KMO was 0,86, indicating that factor analysis is appropriate. The decision whether to include characteristic into a factor was based on several principles (see, for example Field, 2009), including: characteristic loadings equal to or above 0,50; eigenvalues equal to or above 1,0; and the decision also included the recommendation that factors extracted should account for at least 60 % of the variance. As a result, a five-factor solution which categorized the 23 home appliance characteristics and explained 65,2 % of the variance was identified. We also tested the reliability and validity of measurement. We tested reliability using Cronbach's Alpha. Cronbach's Alpha coefficient was higher than 0,70 in all cases and indicated that the tested measurement scale is reliable. We tested validity with convergent validity and used Pearson's correlation coefficients. The correlation coefficients within each factor are high and statistically significant, indicating the existence of convergent validity. Table 2 shows the results of five factors derived from factor analysis labelled as *Sales environment*, *Price*, *User features*, *Design features* and *Technical features*.

According to the results of factor analysis we applied the derived factors to further calculate the derived importance and the stated importance of customer satisfaction which were then used to construct the Kano model of customer satisfaction. We calculated the stated importance

(x axis in the Kano model) as the mean importance rating given to home appliance characteristics by respondents. In order to convert the means into importance weights we normalised the means. The derived importance (y axis in the Kano model) was obtained by correlating rating of characteristics with the overall rating. Subsequently we performed the normalisation. Figure 4 presents the Kano model according to the data used.

According to the Kano's model characteristics that have a high stated and low derived importance are least expected characteristics (must be attributes). Characteristics like energy class of home appliance and serially fitted protective equipment are the minimum expected for home appliance. Characteristics with low stated and high derived importance are called delight attributes. The marketers should concentrate on these attributes. In this study wider knowledge of salesperson, professional skills of salesperson, design of home appliance, professional approach of salesperson, brand of home appliance, basic price of home appliance, appearance of exhibition place where home appliance was presented and more affordable home appliance in comparison to competitive brands emerge as the delight attributes. Others are linear attributes. If they are important, then pay attention. The most important characteristic is the guarantee period, as stated and derived importance is high. If they have low importance, one should not pay much attention to those characteristics in the sense of de-

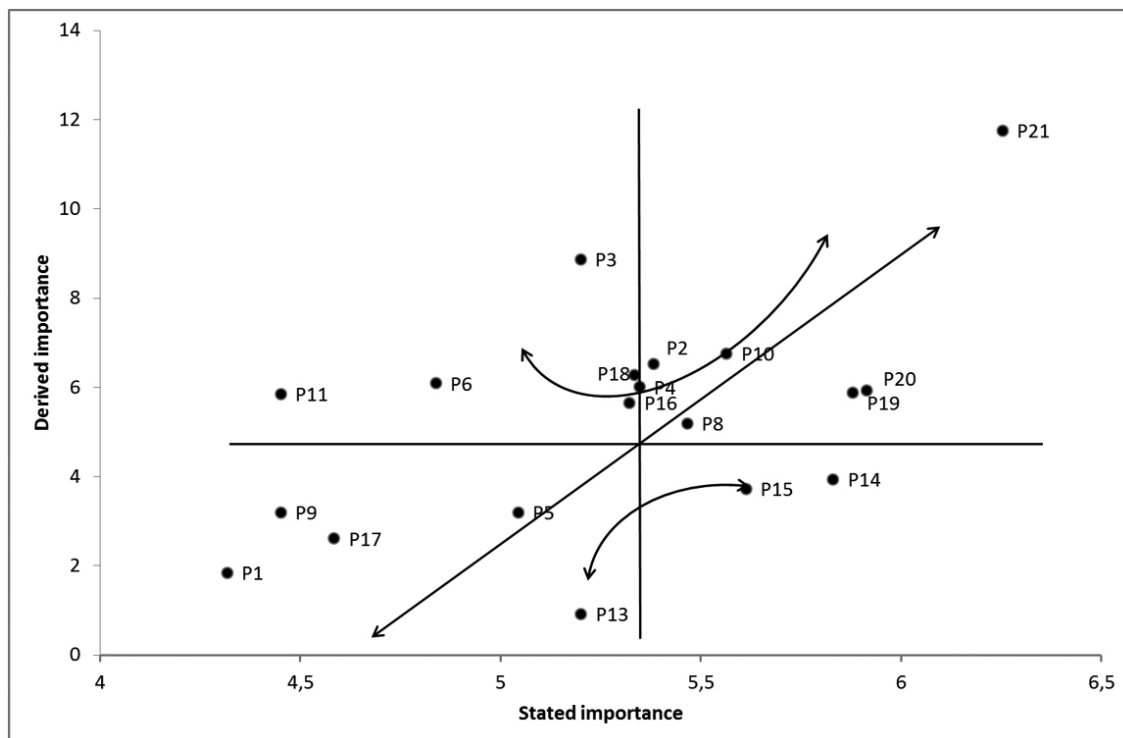


Figure 4: Kano model for the study of home appliance



sign. Spending too much on such characteristics may not be in a linear relationship with profitable returns.

In addition, we wanted to understand respondent opinions and drivers of their evaluation in order to gain perspective of how we can improve their experiences and perhaps company profitability. In such a manner we analysed which factors are the strongest drivers or predictors of repeat purchase. Factor analysis provides us with the set of quantities that can be used in a regression or other multivariate analysis technique (in comparison with the original intercorrelated variables). Regression works in the best possible way when predictors are uncorrelated (Iacobucci, 2013; Feinberg et al., 2013). We have to be aware that variables that we are given are never uncorrelated. Alternatively, factors (when they are extracted using orthogonal rotation, like varimax) are always perfectly uncorrelated (Field, 2009). This enables further statistical analysis. According to this, we completed our analysis by using the factors in a logistic regression to help determine which are the strongest drivers or predictors of repeat purchase. The repeat purchase was a dummy variable indicating 1 if respondent would buy another home appliance product of a brand X if he/she had to buy another home appliance product and indicating 0 otherwise. We used the variable repeat purchase as dependent variable in a logistic regression with the five factors as predictors. The logistic regression results are shown in Table 3.

The logistic regression analysis showed that the model as a whole is statistically significant ( $\chi^2=14,98$ ,  $p<0,010$ ). Estimate of the variance that can be predicted from the combination of the five factors, Cox&Snell and Nagelkerke  $R^2$  is 12,2 percent and 17,1 percent respectively, which means that the five factors explain about one eighth (one sixth) of the variation in repeat purchase. Table 3 presents the odds ratios, which suggest that the odds of repeat purchase are increasingly greater as user features (factor 3) scores increase. The odds of repeat purchase improve by 2,236 for each unit increase in users' features score.

## 6 Discussion and conclusion

In this study user features are those which represent the strongest driver of repeat purchase and they are positively correlated with repeat purchase. This may indicate that the decision of the company to adopt the simplicity philosophy has proven to be the right orientation for the company combining lifestyles and personalities. The company products are designed following experiences and technology. The creation and realisation of the company products is driven by the needs of different types of people. The company plays a challenger on the market several times; such as the decision to adopt the life simplicity philosophy. The company was in the position to follow such market strategy as the company faces economies of scale and therefore lower costs per unit. Additionally, the company is small enough to be flexible. The company product range is characterized by innovative and design-oriented products with high technical perfection and functionality. The company has become an innovative brand with an emphasis on design, geared to the needs of customers. The company relies on proven and useful solutions to achieve the most efficient use for household appliances. From the principle of "bewusst robust" (consciously robust), today's principle of the company is to create attractive design-oriented household appliances to make the daily lives more pleasant and less complicated. The company's decision, supported by ongoing customer satisfaction measurement enables the company to apply continuous improvement and total quality management philosophies, as well as to improve company performance in the context of economic globalisation.

From the methodological point of view, limitations in the research can be found in the number of respondents. Having a sample size which is large enough, ensures a representative distribution of the population and finding significant relationships from the data. Another limitation of the research is the omission of a variable which would indicate the country of origin of the respondents. Having such a variable would allow comparisons to be made, to form independent groups and test the differences between the groups and to account for other impacts, such as general economic conditions. However, the latter could be seen

Table 3: Logistic regression analysis results (Source: author calculations)

Coefficients	B	Std. error	Exp(B)	Sig.
Constant	0,825	0,218	2,283	0,000
Factor 1	0,018	0,221	1,018	0,936
Factor 2	-0,055	0,225	0,947	0,808
Factor 3	0,805	0,241	2,236	0,001
Factor 4	0,163	0,216	1,177	0,450
Factor 5	0,142	0,213	1,152	0,506

as a possible direction for future research.

The findings of our research have both theoretical and practical implications. It is believed that the findings of this research enable better understanding of the complexity of customer satisfaction and the Kano model itself. Our research adds to the relatively scarce literature in Slovenia in the relation of using the Kano model and integrating this model with other models and tools to support optimization of business decisions. Above all, the research of customer satisfaction influences the improvement of quality management and in general the performance of a company.

From a theoretical perspective, our research contributes to identification of the home appliance factors and to construction of the Kano model of customer satisfaction based on the calculation of the stated and derived importance. The Kano model can be used in many different ways; however it always provides the three category view of the customer. On top of that, the findings of our research indicate which factors are the strongest drivers/predictors of repeat purchase. In order to optimize business decisions, it is imperative to focus on people as customers and emphasize customer needs and priorities. Increased customer satisfaction guarantees long-term success of a business through customer loyalty. What is more, measuring and delivering what customers really want enables companies to gain insights into which elements of value do matter more than others. When optimally combined, they translate to successful business performance.

When customers evaluate a product or service, they weigh its perceived value against the price. The price side of the equation is considered to be the easy part, whereas the other side of the equation is more challenging, as it is connected with the question what customers really value. This is difficult to answer. The direction for future research therefore could be seen in building a new model of customer value which requires anticipating what else customers might consider valuable and enables a company to find new combinations of value that its product or service could deliver without missing the message what customers try to achieve in a certain circumstance. The model could be of help for benchmarking purposes and when recognized as growth opportunity it can add to stronger customer loyalty and better business performance.

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## Uporaba Kano modela za izboljšanje zadovoljstva potrošnikov

**Ozadje/namen:** Zanimanje za merjenje zadovoljstva potrošnikov se kaže v koristih, ki jih le-to prinaša, in sicer pridobitev lojalnosti potrošnikov, prenašanje potrošnikovih dobrih izkušenj od ust do ust, ponovni nakup, izboljšanje tržnega deleža podjetja in dobičkonosnosti. Področje integriranja Kano modela zadovoljstva potrošnikov z ostalimi modeli in orodji, ki omogočajo razvoj ali izboljšanje proizvoda oziroma določanje trženjskih strategij, je na slovenskem področju relativno neraziskano. Cilj raziskave je oblikovati Kano model za izboljšanje zadovoljstva potrošnikov gospodinjskih aparatov.

**Zasnova/metodologija/pristop:** Podatki so bili zbrani preko spletne ankete med naključno izbranimi posamezniki iz podatkovne baze končnih uporabnikov. Faktorska analiza glavnih komponent je bila uporabljena za identifikacijo dejavnikov lastnosti gospodinjskih aparatov. Nato smo izračunali izpeljano in navedeno pomembnost, kar je bilo uporabljeno za oblikovanje Kano modela zadovoljstva potrošnikov. Prav tako smo analizirali, kateri dejavniki v največji meri vplivajo na ponovni nakup z uporabo multiple regresijske analize.

**Rezultati:** Identificirali smo dejavnike gospodinjskih aparatov, pri čemer so to prodajno okolje, cena, uporabniške, oblikovalske in tehnične lastnosti. Na podlagi rezultatov smo nato oblikovali Kano model, kjer analiza presega kvalitativni okvir in pomeni implementacijo dveh pristopov, izpeljane in navedene pomembnosti. Tržniki naj se osredotočijo na lastnosti kot so širše znanje prodajalca, strokovne sposobnosti prodajalca, dizajn gospodinjskega aparata, blagovna znamka. Uporabniške lastnosti v največji meri vplivajo na ponovni nakup.

**Zaključek:** V članku smo povezali Kano model z merjenjem zadovoljstva potrošnikov, kar predstavlja prispevek k teoriji trženjskega raziskovanja. Rezultati raziskave lahko služijo kot podpora optimizaciji poslovnih odločitev kot tudi za nadaljnje znanstveno raziskovanje

**Ključne besede:** optimizacija; poslovne odločitve; Kano model; merjenje zadovoljstva potrošnikov



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# Analysis of Individual Aspects Influencing Non-purchasing in an Online Environment and Consumer Willingness to Purchase Custom-Made Apparel

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**Purpose:** The main purpose of the study was to assess the opinion of online consumers about the possibility of making custom apparel using 3D body scanning technology in an online environment and to investigate the shopping experience of consumers who purchase in the online apparel market. In order to be able to propose solutions to improve the online shopping experience, we also investigated aspects influencing non-purchasing in an online environment.

**Methods:** An online questionnaire on shopping experience, influences on the purchase, and the process of online apparel shopping using advanced technology was prepared and distributed via several online channels to the consumers who purchase apparel online. The questionnaire was completed by 76 respondents from different European countries, the United States and Australia. In order to analyze individual aspects influencing non-purchasing in an online environment, an exploratory factor analysis was performed.

**Results:** The factor analysis revealed that the two broad dimensions of reasons why consumers have never bought any ready-to-wear apparel online despite browsing are a misperception of product integrity and time-consuming searching. The results show that the proposed solutions to improve the online apparel experience, such as making custom apparel using advanced technologies, have a positive impact on the decision of the consumers to purchase on the online apparel market. It turned out that a high proportion of potential consumers are willing to share their body dimensions through 3D body scanning technology in order to improve the fit of the apparel.

**Conclusion:** According to the results, we expect that the advanced 3D body scanning technology would provide substantial progress regarding fit, visualization, and manufacturing of custom-made apparel when purchasing in online stores.

**Keywords:** *online shopping apparel; custom made apparel; consumers' shopping experience*

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## 1 Introduction

The main idea and motive for this research paper derives from the fact that the consumer wants to purchase high-quality apparel, which satisfies their fitting preferences, in an easy and cost-effective manner. This is not a problem when it comes to small brick-and-mortar shops where the consumer can touch the fabric, look at the color,

try on the apparel, etc. The challenge arises in online apparel stores, where the consumer is able to evaluate the apparel qualities only virtually. Online apparel stores provide consumers with various benefits, such as saving time and money, 24-hour availability, better service in general, a fast (and easy) process of shopping and a greater choice of products compared with brick-and-mortar shops (Mon-suwe, Dellaert, & Ruyter, 2004; Loker, Ashdown, Cowie,



& Schoenfelder, 2004; Orzan, Iconaru, Popescu, Orzan, & Macovei, 2013). However, it is well known that a high proportion of the returned apparel purchased in an online store is due to the inability to find the right size and/or due to the dissatisfaction with the fit of ready-to-wear apparel. Also, according to Olaru, Filipescu, Niculescu, and Filipescu (2013) “unsold products do not reflect that they are obsolete or do not have the best quality in terms of accuracy of manufacturing technology, appropriate use of raw and auxiliary materials, but they were not purchased because they do not correspond to the dimensional morphological requirements of the users”. The cause of this problem stems from the standardization of the apparel sizing system, either due to the obsolescence of the existing standards or variations in body shapes and sizes that the existing standards do not account for, or due to the size disparity between the apparel suppliers. Most manufacturers of ready-to-wear apparel set standard sizes depending on their target market (Ashdown & Dunne, 2006; Faust, Carrier, & Baptiste, 2006; Kim & LaBat, 2013). However, many groups (slim, plus-size, very tall, elderly women, black women and others) do not belong to the target group of the clothing industry and thus they cannot find apparel that fits their body size and desired style (Ashdown & Dunne, 2006; Romeo & Lee, 2015).

Gültepe and Güdükbay (2014) emphasized that trying the apparel on is one of the most time-consuming stages of apparel shopping, and the problem of fitting ready-to-wear clothes is especially present in online shopping. When purchasing apparel online, consumers are unable to touch and feel the apparel (Wu, Hwang, Sharkhuu, Tsogt Ochir, 2017). To facilitate the evaluation of fit of ready-to-wear apparel to the individual body shape, some online retailers already enable consumers to use virtual fitting rooms for trying on the apparel on their website through virtual models tailored to the physical dimensions of their body. However, the existing virtual models cannot fully capture the properties of the human body (Pilar, Stjepanović, & Jevšnik, 2013). According to Kozar et. al. (2014) “virtual body models are limited to a standing posture with standard body shape characteristics”. Also, getting the physical dimensions of the consumer (height, bust, waist, hips and arms) is based on the self-measurement (using a measuring tape) which has certain drawbacks (see Ashdown & Dunne, 2006; Park, Nam, Choi, Lee, & Lee, 2009).

Despite the efforts of online retailers to provide a better virtual experience using the help of interactive technology, it is first necessary to solve the problem of the current system of ready-made apparel sizes and to enable a reliable acquisition of the physical dimensions of consumers. Ives and Gabriele (2003) emphasized that it is important to improve the consumers’ satisfaction and comfort, where a good alternative to stock sizing is a custom-made clothing service (as cited in Kim et al., 2017).

The solution that we propose could be purchasing cus-

tom-made apparel online using innovative technologies. Integrated anthropometry information technology (3D body scanner, WEB camera) and CAD/CAM software, which includes 3D virtual apparel simulation software, provide an opportunity for purchasing custom-made apparel over the Internet. With the anthropometry information technology, »3D digitized anthropometric data can easily be collected in a few seconds and accessed immediately from anywhere in the world through the Internet« (Niculescu, Mielicka, Salistean, Napieralska, Popescu, & Mocenco, 2016). This would guarantee that apparel would satisfy the requirements of the consumers. The consumers’ preferences regarding apparel fit may be defined as the relationship between the body, garment dimensions, and the expectations the wearer has in regard to the fit (Chattaraman, Simmons, & Ulrich, 2013). Therefore, shopping for custom-made apparel via the Internet can solve the issues consumers have when purchasing ready-to-wear apparel.

In our study we investigated the experiences of consumers when shopping for apparel online and their shopping habits. Therefore, the purpose of our study was to determine the shopping experiences of consumers who purchase in the online apparel market and to analyze the willingness of potential consumers to purchase custom-made apparel in the online apparel market. In addition, we investigated if the offered solutions that incorporate advanced technologies on the Internet would improve their online shopping experience of the apparel and whether they would be willing to entrust volunteering their body dimensions to online retailers.

## 2 Literature Review

Online consumers are searching and evaluating information regarding the effectiveness of apparel through the virtual product experience (Yu, Lee, & Damhorst, 2012). Therefore, online shops on their websites try to provide the consumer with the most realistic experience, similar to shopping in a brick-and-mortar store. This is achieved through the integration of advanced image interactive technology (Yu et al., 2012), which enables the creation and manipulation of the products or the environment to simulate the actual experience with the product and the environment (Yang & Young, 2009), for example: expansion or zoom, 3D rotation and personal 3D models in a virtual fitting room for trying on apparel. Per authors Loker, Ashdown, and Carnrite (2008); Kim and LaBat (2013); Yang and Young (2009); Boonbrahma, Kaewrata, and Boonbrahma (2015) virtual fitting technology in the online store solves problems such as the fit of ready-to-wear apparel, choosing the appropriate size and style, and overconsumption of time on the purchase.

Most online stores on their websites provide information about standard sizes and the measurement procedure which helps the consumers to choose the appropriate size

more easily. Some online stores on their websites also offer virtual fitting rooms, where the physical dimensions of the virtual mannequin can be changed and adapted to the physical dimensions of the consumer (neck, chest, waist, hips). Consumers can, before the purchase, virtually try on a garment and choose the size that best fits their body shape. In both cases, the consumers are measured by using a measuring tape and on the basis of the obtained physical dimensions choose an appropriate size which fits them best. However, it has been shown that self-assessments are inaccurate by as much as 6 cm (Yoon and Radwon as cited in Ashdown & Dunne, 2006). Authors Kim and Choi (2002) indicate that previous studies have shown that apparel consumers do not generally familiarize themselves with their body measurements (as cited in Park et al., 2009). We conclude that the apparel consumers' lack of knowledge about their body measurements, as well as the technical difficulties involved while taking those measurements, are impediments to the proper selection of clothing sizes when shopping online.

In addition, some online stores have virtual fitting rooms that utilize a 3D scanner to capture the physical body dimensions of the consumer. Based on the obtained physical dimensions, it enables the consumers to try on apparel in a virtual fitting room before they make a purchase. Studies have shown that the 3D scanner enables a reliable acquisition of the physical dimensions (Loker et al., 2004). However, for the consumers who do not belong to the target market of apparel manufacturers, the use of a 3D body scanner (i.e. the exact body measurements acquisition) does not guarantee that they will find the ready-to-wear apparel that fits their body shape. According to Ashdown and Dunne (2006), the consumer dissatisfaction with the fit of apparel is very high (62% for men and 50% for women). Another study shows that 70% of women aged 55 and over are dissatisfied with the fit of ready-to-wear apparel (Goldsberry et al. as cited in Ashdown & Dunne, 2006). One of the reasons is that most manufacturers of ready-to-wear apparel set standard sizes depending on their target market (Anderson et al., 2001; Ashdown & Dunne, 2006; Faust et al., 2006; Kim & LaBat, 2013). Another reason is that "garment order initiators do not adhere to the standard sizes charts and garment manufacturers are incapable or unwilling to produce garments that meet the order initiators' specifications" (Faust et al., 2006; Xu & Huang, 2003). A survey (Faust et al., 2006) showed a number of factors that contribute to this situation: obsolescence of the existing standards, variations in body shapes and sizes that the existing standards do not account for and marketing ploys aimed at flattering certain consumers. Moreover, the estimate of dimensions used in current 2D patterns represents only a general dimension with a small range of fundamental measurements such as neck base girth, arm-hole girth, bust girth, waist girth, hip girth, body depth, etc. (Fang & Tien, 2013). Such systems do not take into

account the detailed dimensions and specific surface configurations of individuals (Fang & Tien, 2013; Ashdown & Dunne, 2006; Faust et al., 2006). Measurements of consumers even in the same size category vary (Apeageyi & Otieno, 2007). Due to the above mentioned, consumers are forced to try on several different brands and sizes before finding the apparel that fits them best (Anderson et al., 2001), but also to try on a large number of apparel items, which does not guarantee that the consumer will find a garment that fits well (Ashdown & Dunne, 2006). Based on the results of these studies, we can conclude that many consumers do not fall within the target group of the apparel industry and for this reason cannot find the apparel that fits their body dimensions and the desired style. It follows that the technology for the virtual fitting of ready-to-wear apparel (which uses parametric body or a 3D body scanner) is intended primarily for the consumers who, in terms of size, (dimensions of the body) belong to the target group of the apparel industry.

Different body shapes pose a challenge for the garment industry. However, the development of technology makes the fitting of the apparel to the consumers' needs possible (Lee, Kunz, Fiore, & Campbell, 2002). With advanced 3D technology, there would certainly be substantial progress regarding fit, visualization, and manufacturing of custom-made apparel when purchasing in online stores. Ashdown and Dunne (2006) emphasized that the success patterns of a custom fit ultimately depend on the reliability of the body measurement process. Therefore, 3D body scanning systems and CAD/CAM software which includes 3D virtual apparel simulation software may carry commercial potential in the apparel industry of custom-made apparel for retail over the Internet.

To summarize, online stores can offer an alternative solution; custom-made apparel, that enables the development of apparel which fits the consumer perfectly. Also, in this way, the consumers who, according to their body dimensions, do not belong to the standard sizing system, would have the opportunity to buy apparel that corresponds to their requirements regarding fit, comfort and style.

The global apparel industry continues a positive growth trend. By 2019, the global apparel market will have grown to 1.51 trillion U.S. dollars (Statista, 2017a). A robust growth is expected in emerging markets and the United States' apparel market (Statista, 2017b). According to Eurostat (Eurostat, 2017a), in 2015, 184,205 enterprises in the EU-28 were engaged in textile and apparel manufacturing and their annual turnover was 148,610.3 million EUR. In 2014, they employed 1,431,420 employees. On the other hand, the EU-28 countries have more than 511,000,000 (Eurostat, 2017b) potential consumers (estimated by number of persons with residence in one of these countries), while the number of potential online consumers is even higher, since the world population already exceeds 7.5 billion people. Lectra, one of the world leaders in integrat-

ed technology solutions, expects that four critical trends will shape the global apparel industry in the next five to ten years: millennials, technology, industry 4.0 and China (McGregor, 2016). Millennials, the people born between 1981 and 1997, bring a lot of challenges for the apparel industry, since they want quality and more sustainable products at low prices. The Executive Vice President of Sales at Lectra, Edouard Macquin, forecasts that in the apparel industry, the following new technologies will become common (McGregor, 2016): “collaborative solutions, 3D rendering, connected devices and the Internet of Things, augmented reality, virtual reality and analytics, making the data speak and providing information.” In Industry 4.0, an era of automatization and data exchange in the cloud, one of the major challenges will be moving from mass production to mass customization. The manufacturers and the consumers will have a direct connection, without (or at least with fewer) intermediaries (McGregor, 2016).

Based on the literature review on problems in shopping for apparel online (e.g. Loker, Ashdown, and Carnrite (2008); Kim and LaBat (2013); Yang and Young (2009); Boonbrahma, Kaewrata, and Boonbrahma (2015)) one of our objectives was to investigate the shopping experience of the consumers who purchase in the online apparel market and to investigate the individual aspects influencing the decision of consumers, who, in spite of browsing and searching do not purchase the apparel. We propose the following research questions:

- RQ1: Which factors influence online apparel purchases?
- RQ2: How many dimensions (or factors) are contained in the individual aspects influencing non-purchasing in an online environment and what is their content?

Based on the literature review on drawbacks and consumers' dissatisfaction with ready-to-wear apparel due to the use of standardized sizes and inappropriate fit, the aim of the paper is to investigate the consumers' willingness to purchase custom-made apparel tailored according to the specifications of an individual consumer, using advanced technologies. In the third research, the question (RQ3) we investigated was whether the respondents would be willing to give their body measurements while purchasing custom-made apparel online, since the accurate body measurements are a prerequisite for the production of customized apparel.

- RQ3: What proportion of the potential consumers would be willing to give their body measurements when purchasing custom-made apparel online?

### 3 Methodology

#### Instrumentation

We prepared a questionnaire based on several sources: Loker et al. (2004), Hosun (2012), and Yu et al. (2012). The questionnaire was tested by 10 respondents, minor grammatical errors were found and eliminated. The English version of the questionnaire was proofread by a native speaker. In the final version of the questionnaire, we decided not to set up hard warnings on all questions, instead, we decided on soft warnings that enable the respondent to complete the survey, even if they do not provide answers to all the questions. We received a proposal to replace the term “apparel”, due to its archaic connotation, with a more modern term “clothing”. However, on the basis of the literature review, we decided to keep the term “apparel”. The questionnaire was prepared in accordance with the aims of the research and was divided into four thematic parts. The first part ‘Shopping experiences’ was designed to discover the importance of online apparel shopping to the consumers. All variables were measured on a 5-point Likert type scale of agreement, where 1 means ‘strongly disagree’ and 5 ‘strongly agree’.

In the second part, entitled ‘Influences on the purchase’, respondents were asked to estimate the factors that affected their decision to purchase the apparel online, using the 5-point scale of influence. They were also asked to estimate the factors that influence their decision not to purchase the apparel in spite of browsing and searching in online stores. In addition, we were also interested to know whether the respondents ever returned the apparel they purchased and for what reason.

The last thematic part was devoted to the development of a virtual product and to the process of online apparel shopping using advanced technology. Within this part, the respondents were asked if the following solutions would affect their online purchase of the apparel: virtual fitting of the apparel, custom-manufactured apparel according to the body dimensions using advanced technologies (3D body scanning, CAD/CAM programs, etc.), the aesthetic properties of the apparel shown as realistically as possible, a flexible date of delivery, higher quality of the apparel (materials and/or workmanship), the apparel being safe and harmless to their health and the easy purchase of the apparel.

At the end of the survey, socio-demographic questions were included, about gender, age, education, occupational status and place of residence.

#### Data Collection

An anonymous online survey using web portal (www.lka.si) was conducted in July and August 2013. The survey focused on the population that buys apparel online.

The link to the questionnaire was published: (a) on three different forums of shopping centers worldwide, (b) on five well-known fashion forums, (c) on official Facebook forums of nine online stores of large world-renowned brands. These brands include apparel for men, women and youth and have online stores. Additionally, we asked twelve online stores of world-famous apparel brands and the students of the clothing and textile department at a U.S. university in the West to publish our questionnaire link on their Facebook pages. The decision to distribute the questionnaire via various channels was made based on the previous research where surveys were conducted mainly on students or respondents who receive special benefits to participate in the research.

Altogether we received 76 completed questionnaires. We would like to emphasize that in contrast to the majority of other studies on apparel customization, we did not offer any material incentives to the participants included in the research.

## 4 Results

### Sample Characteristics

Our study included 41% men and 59% women. Their age ranged between 22 and 48 (with the average age of 33). More than half of the respondents (59%) have a university diploma and 76% are employed. The majority of the respondents (80%) are from Europe (Slovenia 57%; Serbia 24%; and the rest of the respondents were from Montenegro, Austria, Bosnia and Herzegovina, Bulgaria, France, Italy, Russia and the United Kingdom). The other respondents were from the USA and Australia (Table 1).

### Descriptive Statistics for Online Shopping Experiences

In the first thematic part, the respondents answered several questions on online shopping apparel experiences and views using the 5-point Likert type scale of agreement.

It turned out (Table 2) that the respondents mostly believe that online shopping for apparel is 'Time saving' for them ( $M = 3.84$ ). The other three options received lower means, 'Fun' ( $M = 3.25$ ), 'Pleasure' ( $M = 3.10$ ) and 'Obligation' ( $M = 2.30$ ).

Table 1: Sample characteristics

		Group	%
Gender		Men	41%
		Women	59%
Age		20 – 30 years	29%
		31 – 40 years	61%
		41 – 50 years	10%
Education		Less than High school diploma	5%
		A levels/High school diploma	15%
		Bachelors degree/University	46%
		Master's Research degree, PhD Degree	20%
Country	Europe	Austria	2%
		Bosnia and Herzegovina	2%
		Bulgaria	2%
		France	2%
		Italy	2%
		Montenegro	4%
		Russia	2%
		Serbia	24%
		Slovenia	57%
		The United Kingdom	2%
	America	North America	18%
	Australia and Oceania	Australia and Oceania	2%

Table 2: Viewpoints on online apparel shopping

Online apparel shopping represents...	<i>N</i>	<i>M</i>	<i>SD</i>
... pleasure	63	3.10	1.21
... fun	63	3.25	1.05
... obligation	57	2.30	1.05
... time saving	62	3.84	.96

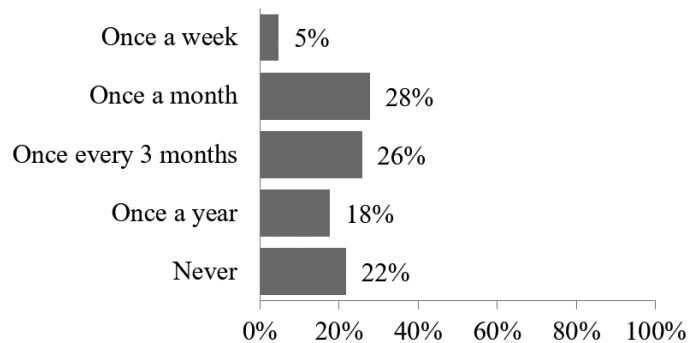


Figure 1: Frequency of purchasing apparel online

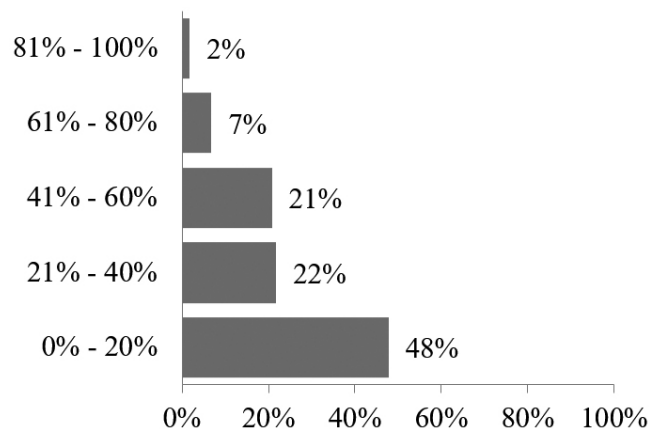


Figure 2: Percentage of online purchases in the last 12 months

Further, we wanted to know how often they purchase apparel online. The majority of respondents make online purchases once a month (28%) or once every three months (26%). They are followed by consumers who have never bought apparel online (22%) and those who buy once a year (18%), while the rest of the respondents purchase online once a week (Figure 1).

Since the consumers are purchasing both in traditional and online shops we wanted to know what percentage of all the apparel bought in the last year they bought online. It turned out that the traditional shopping still prevails over online shopping. Namely, the majority of respondents

(48%) bought at most 20% of apparel online, followed by consumers who bought 21%-40% of apparel online (22%) and consumers who bought 41%-60% (21%). Only 2% of the respondents bought online more than 80% of the apparel in the last year (Figure 2).

In the second thematic part of the questionnaire and in RQ1, we were interested to know how much the given elements affect online apparel purchasing. The respondents answered using the 5-point scale of influence, and the results are presented in Table 3. On average, they decide on online shopping mostly because of 'Time saving' ( $M = 4.19$ ), 'Avoiding crowds' ( $M = 3.92$ ) and 'Home delivery'



Table 3: Factors affecting online apparel purchases

Variables	<i>N</i>	<i>M</i>	<i>SD</i>
Online shopping is fun.	49	3.20	.98
Time saving	48	4.19	.76
Avoiding crowds	48	3.92	1.01
Home delivery	48	3.88	.84

Table 4: The descriptive statistics of nine variables measuring individual aspects that influence the consumers' decision not to purchase apparel in spite of browsing and searching.

Note. *N* – number of observations, *M* – mean, *SD* – standard deviation

Variables	<i>N</i>	<i>M</i>	<i>SD</i>
No personal contact with apparel (i.e. touch and feel, weight).	43	3.56	.959
Cannot try on apparel (i.e. fit, comfort, appearance).	43	3.84	1.153
Visual and aesthetic risk (i.e. style, color and print, matching with other apparel).	43	3.51	1.009
Aesthetic properties (style, color and print) are not realistically shown.	43	3.60	.979
I am not sure about fit and size.	43	3.93	.961
The risk of getting used apparel in spite of ordering it brand new.	43	2.56	1.053
Delivery date is not flexible.	43	2.74	.928
Cannot assess the quality of apparel (fiber, manufacturing).	43	3.23	.947
Browsing and searching for apparel is very time-consuming.	43	2.88	1.005

( $M = 3.88$ ). As the least important element, they estimated that 'Online shopping is fun' ( $M = 3.20$ ).

One of the problems that online shops are facing is returning the product. More than half (59 %) of the respondents who are purchasing online said that they already returned an apparel item they had purchased online. As the most common cause they estimate 'the size does not match' (45%), while only 2% of respondents stated that the reason was 'Damaged on delivery'.

### Descriptive Statistics for Variables Indicating Reasons for Non-purchasing in Online Stores

In addition, we asked the respondents about the individual aspects that have influenced their decision not to purchase the apparel, in spite of browsing and searching in an online store. The respondents provided their answers on the 5-point scale of influence (1 meaning 'no influence' and 5 meaning 'big influence'). According to Table 4, the aspect with the highest influence on the decision not to purchase the apparel in spite of browsing and searching for it, is 'unsure about fit and size' ( $M = 3.93$ ). The aspect with the second highest impact is 'cannot try on the apparel' ( $M = 3.84$ ), followed by the aspect 'the aesthetic properties (style, color and print) are not realistically shown' ( $M = 3.60$ ). The aspect with the lowest impact on the decision not to purchase is 'the risk of getting used apparel in spite

of ordering it brand new' ( $M = 2.56$ ).

### Factor Analysis for Individual Aspects Influencing Non-Purchasing Apparel Online

As stated above, in spite of browsing and searching, some consumers do not end up making a purchase. In order to analyze individual aspects influencing non-purchasing in an online environment, an exploratory factor analysis was performed. The analysis was based on nine variables measuring individual aspects influencing the decision of consumers not to make an online purchase of the apparel in spite of browsing and searching. The descriptive statistics are presented in Table 4.

One could argue that the sample is too small to perform a factor analysis as we do not have at least 100 cases and case-to-variable ratio is far below 10, but based on the empirical data, Arrindell and van der Ende (as cited in Field, 2013) concluded that the case-to-variable ratio made little difference to the factors' solutions. More important than the overall sample, the size and ratio between cases and variables in the stability of the obtained solution are factor loadings. If at least four factor loadings are above .6, then the factors are reliable regardless of the sample size (Guadagnoli & Velicer, 1988), and Table 6 shows that we got two factors where the first one has all the factor loadings above .76 and the other has all the factor scores above .71,

Table 5: Eigenvalues and the percentage of explained variance  
 Note. Extraction Method: Principal Component Analysis

Component	Initial Eigenvalues			Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.754	41.708	41.708	3.754	41.708	41.708
2	2.202	24.469	66.177	2.202	24.469	66.177
3	.718	7.975	74.152			
4	.617	6.852	81.004			
5	.526	5.847	86.851			
6	.426	4.733	91.584			
7	.299	3.318	94.902			
8	.249	2.764	97.667			
9	.210	2.333	100.000			

Table 6: Rotated 'pattern' component matrix  
 Note. Extraction Method: Principal Component Analysis. Rotation Method: Oblimin with Kaiser Normalization.  
 The factor scores smaller than .3 are suppressed, variables are ordered according to the decreasing factor scores.

Variables	Component	
	1	2
Cannot try on apparel (i.e. fit, comfort, appearance).	<b>.887</b>	
Visual and aesthetic risk (i.e. style, color and print, matching with other apparel).	<b>.809</b>	
No personal contact with apparel (i.e. touch and feel, weight).	<b>.805</b>	
Aesthetic properties (style, color and print) are not realistically shown.	<b>.775</b>	
I am not sure about fit and size.	<b>.763</b>	
Delivery date is not flexible.		<b>.830</b>
The risk of getting used apparel in spite of ordering it brand new.		<b>.740</b>
Browsing and searching for apparel is very time-consuming.		<b>.711</b>
Cannot assess the quality of apparel (fiber, manufacturing).	.366	<b>.707</b>

indicating that our solution is reliable.

Further, the reliability of the questionnaire was tested with the Cronbach's Alpha Coefficient, where it turned out that the questionnaire has quite a high reliability,  $\alpha = .802$ . In addition, the adequacy of the sample was confirmed with Kaiser-Meyer-Olkin test,  $KMO = .805$  (it is 'good' according to Hutcheson and Sofroniou (1999) and Field (2013)). Bartlett's test of sphericity (36)=166.35,  $p < .000$ , indicating that correlations between items are sufficiently large for performing the Principal Component Analysis. The multi-collinearity was ruled out based on the inspection of the correlation matrix, where the largest significant correlation coefficient between 'aesthetic properties (style, color and print) are not realistically shown' and 'visual and aesthetic risk (i.e. style, color and print, matching with other apparel)' was equal to .692 ( $p < .000$ ), which is far below .8. In addition, the value of the determinant of the correlation matrix should be greater than .00001 (Field,

2013), and in our case it was equal to .013.

Among nine individual aspects that influence the consumers' decision not to purchase the apparel online, in spite of browsing and searching, two factors were revealed based on three common rules of extraction (Field, 2013): (i) Kaiser's criterion of extracting factors with eigenvalues higher than 1 ( $\lambda_1 = 3.7$ ,  $\lambda_2 = 2.20$ ,  $\lambda_3 = .72$ ), (ii) the 'scree' plot (not reported here but can be reconstructed with eigenvalues from Table 5), which clearly shows the point of inflexion at the third factor suggesting that the solution contains two factors, and (iii) the total percentage of explained variance was greater than 60 % since it was equal to 66 % (Table 5). Therefore, an answer to the first part of RQ2 is that there are two dimensions (or factors) based on individual aspects influencing non-purchasing in an online environment.

Table 6 shows factor loadings after the oblimin rotation. It should be noted that the factor scores lower than

.3 are suppressed and that variables are ordered according to the decreasing factor scores. The content of both dimensions obtained from individual aspects influencing non-purchasing in an online environment (the second part of RQ2) can be obtained from the factor scores in Table 6. For each variable, the factor score written in bold indicates to which factor it belongs. The items that cluster on the first factor suggest that it represents a 'misperception of product integrity', while the second factor represents 'browsing and delivery issues with overall quality'. Several authors (e.g. Field (2013)) suggest that the reliability should be calculated for subscales rather than theoretical scales or the whole questionnaire. Therefore, we calculated Cronbach's Alpha coefficients for both obtained factors. Cronbach's Alpha Coefficient for the first factor is equal to 0.872, and for the second factor it is equal to 0.753, indicating that both subscales are highly reliable.

The factor scores smaller than .3 are suppressed, variables are ordered according to the decreasing factor scores. The correlation coefficient between both obtained factors is equal to .126, indicating that they are weakly connected, so we tried the orthogonal varimax rotation, as well. The solution was practically the same, with slightly different factor loadings. Therefore, we decided to keep and interpret the non-orthogonal solution presented above.

### **Analysis of Consumer Attitudes Toward Improved Shopping Experiences and Their Willingness to Purchase Custom-Made Apparel**

Having in mind the limitations of today's standard sizing system of ready-to-wear apparel and the technological advances in the textile industry, we proposed some solutions that can improve shopping experiences and the whole concept of online apparel shopping. Therefore, in the last thematic part we were interested to know which of the proposed improved shopping experiences would affect the respondent's decision about their online apparel purchases. It turned out that the vast majority of respondents think that all the proposed solutions would positively affect their decision to purchase. More precisely, 'easy purchase of the apparel' was selected by 93% of the respondents, 'aesthetic properties of apparel are shown as realistically as possible' by 85%, 'higher quality of apparel' by 82%, 'apparel that is safe and does not present a health risk' by 80%, 'an option to virtually try on the apparel' by 73%, 'an option to custom manufacture the apparel to your measurements with the use of advanced technologies, e.g. body scanning or CAD/CAM' by 72%, and 'flexible date of delivery' by 57%. In this part, we were also interested to know whether the respondents would be willing to give their body measurements when purchasing custom-made apparel online. According to RQ3, it turns out that a high proportion of the respondents (93%) is willing to share their body dimensions.

## **5 Discussion**

Our study showed that online shopping for apparel is most attractive due to saving time and its amusement aspect, providing a high level of pleasure. Two of the most important reasons for not purchasing, despite browsing and searching in online stores are that potential consumers are not sure about the right size and they cannot try on the apparel. Similar results were established in several other studies (e.g. Yang & Young (2009), Yu et al. (2012)), as well.

Our investigation of the individual aspects influencing non-purchasing in an online environment revealed two factors based on nine measured aspects that influence the decision of consumers not to purchase the apparel online despite browsing and searching. The first factor, 'misperception of product integrity', refers to the aesthetic and functional characteristics of the apparel which should be superb and satisfy the consumer's expectations in every aspect, including comfort, fit, color and pattern. Online consumers of ready-to-wear apparel may be discouraged from purchase, especially due to the dissatisfaction with the fit of ready-to-wear apparel, as a result of the lack of direct experience with the product on the Internet. However, despite the efforts of online retailers to provide a better virtual experience with the help of interactive technology (e.g. expansion or zoom, 3D rotation, personal 3D models in a virtual fitting room), and easier selection of the appropriate size using the information about standard sizes and measurement procedure provided on their websites, consumers in online stores are still not completely sure which size fits them best and whether apparel is comfortable to wear. Fulfilling the consumer's preferences regarding apparel fit, meaning to enable an adequate relationship between the body, garment dimensions and the consumer's expectations about how they want it to fit, is possible to achieve with a custom-made apparel service via the Internet. Our results indicate that the solutions which use advanced technologies for purchasing custom-made apparel online, would positively influence the consumer's decision to purchase on the online apparel market. Furthermore, the results of our study show that a high proportion of the respondents (93%) is willing to share their body dimensions in order to improve the fit of custom-made apparel.

The second factor reveals 'browsing and delivery issues with overall quality' and includes more heterogeneous aspects of online shopping. Variables 'Cannot assess the quality of apparel (fiber, manufacturing)' and 'The risk of getting used apparel in spite of ordering it brand new' refers to the overall quality of the purchased apparel, while the other two variables relate to the time issues of time-consuming Internet browsing and unknown and/or inaccurately estimated delivery time. The second factor shows a quite unique dimension of browsing, delivery issues and concerns about receiving used apparel which was not stressed in previous studies.

## 6 Conclusions

Technology development makes it possible for apparel to meet the consumer's expectations (Lee et al., 2002). With advanced 3D technology (3D body scanning and automated CAD software for custom pattern generation, 3D simulation and visualization of apparel with realistic materials properties) there would certainly be significant progress regarding the fit, visualization, and manufacturing of custom-made apparel when purchasing in online stores.

The results of our study show that the proposed solutions to improve the online apparel purchasing, such as making custom apparel using advanced technologies (scanner body, CAD/CAM software, etc.), the possibility of virtually trying on the apparel, realistic aesthetic properties of apparel, high quality (materials and/or manufacturing) of apparel, safe apparel and an easy process for purchasing apparel, have a positive impact on the decision of the consumers to purchase on the global online apparel market. Also, the results of our study demonstrated that the consumers are willing to give their body measurements for the manufacturing of custom-made apparel.

Therefore, in the future, it is necessary to focus on the development of a system which will allow an easy online purchase of custom-made apparel of high quality at a lower cost. In order to move in this direction, it is necessary to further develop the technology and integrate it into the system. In addition, a cost efficiency analysis of such a system should be conducted from both the consumers' and the manufacturers' perspectives. After the implementation of such a system, the consumers' satisfaction with custom-made apparel bought online should be investigated based on several factors (e.g. personal characteristics, fashion involvement, body satisfaction, purchase behavior, general attitude towards novelties with an emphasis on new technologies) that can potentially impact the intention to use it. In cooperation with online shops providing virtual fitting rooms, a research investigating reasons (e.g. dissatisfaction with the fit) for returning apparel needs to be conducted.

The main limitation of the research is a low response rate, but we have to emphasize that we did not offer any financial or other benefits to the respondents participating in the study, in contrast to the majority of other studies on apparel customization. Another drawback of the study is that we did not ask the respondents about their body measurements, usual standardized sizing, and their satisfaction with their looks. In cooperation with online stores, reasons for returned apparel due to inappropriate fit could be investigated in more detail, as well as the consumers' willingness to purchase custom-made apparel and their satisfaction with the purchase of custom-made apparel, as well as the overall shopping experience.

Future research should investigate differences related to individual aspects influencing non-purchasing in

an online environment and the consumers' willingness to purchase custom-made apparel among respondents from different continents (or countries). In addition, further research should focus on millennials, and their attitudes toward custom-made apparel and positive online shopping experiences, since they account for more than "40 % of retail spending worldwide and that share is only going to grow", as pointed out by McGregor (2016).

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### **Analiza posameznih vidikov, ki vplivajo na ne-nakup v spletnem okolju, in potrošnikova pripravljenost za nakup oblačila po meri**

**Namen:** Glavni namen raziskave je bil pridobiti mnenja spletnih potrošnikov glede možnosti izdelave oblačil po meri z uporabo 3D tehnologije skeniranja telesa v spletnem okolju ter raziskati nakupovalne izkušnje potrošnikov, ki kupujejo oblačila na spletu. Da bi lahko predlagali rešitve za izboljšanje spletnih nakupovalnih izkušenj, smo raziskali tudi vidike, ki vplivajo na ne-nakup v spletnem okolju.

**Metode:** Spletni vprašalnik o nakupovalnih izkušnjah, vplivih na nakup in postopek spletnega nakupovanja oblačil z uporabo napredne tehnologije je bil pripravljen in posredovan prek različnih kanalov potencialnim potrošnikom, ki uporabljajo internet za nakup oblačil na spletu. Vprašalnik je izpolnilo 76 anketirancev iz različnih evropskih držav, Združenih držav Amerike in Avstralije. Za analizo posameznih vidikov, ki vplivajo na ne-nakup v spletnem okolju, smo uporabili faktorsko analizo.

**Rezultati:** Faktorska analiza je razkrila, da obstajata dve širši dimenziji razlogov, zakaj kljub iskanju oblačil na spletu potrošniki še niso opravili spletnega nakupa in sicer: napačna predstavitev integritete izdelka ter časovno zamudno iskanje. Rezultati kažejo, da predlagane rešitve za izboljšanje spletnih izkušenj pri nakupu oblačil, kot je izdelava oblačil po meri z uporabo naprednih tehnologij, pozitivno vplivajo na odločitev potrošnikov, da le-ti kupijo izdelek na spletnem trgu oblačil. Izkazalo se je, da je velik delež potencialnih potrošnikov pripravljen zaupati svoje mere telesa dobljene s 3D skeniranjem, z namenom, da bi se izboljšalo prileganje oblačil.

**Zaključek:** Glede na rezultate pričakujemo, da bodo napredne 3D tehnologije zagotovile velik napredek glede prileganja, vizualizacije in izdelave oblačil po meri pri nakupu v spletnih trgovinah.

**Ključne besede:** spletno nakupovanje oblačil, izdelava oblačila po meri, potrošnikove nakupovalne izkušnje

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# Multi-objective Optimization Algorithms with the Island Metaheuristic for Effective Project Management Problem Solving

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**Background and Purpose:** In every organization, project management raises many different decision-making problems, a large proportion of which can be efficiently solved using specific decision-making support systems. Yet such kinds of problems are always a challenge since there is no time-efficient or computationally efficient algorithm to solve them as a result of their complexity. In this study, we consider the problem of optimal financial investment. In our solution, we take into account the following organizational resource and project characteristics: profits, costs and risks.

**Design/Methodology/Approach:** The decision-making problem is reduced to a multi-criteria 0-1 knapsack problem. This implies that we need to find a non-dominated set of alternative solutions, which are a trade-off between maximizing incomes and minimizing risks. At the same time, alternatives must satisfy constraints. This leads to a constrained two-criterion optimization problem in the Boolean space. To cope with the peculiarities and high complexity of the problem, evolution-based algorithms with an island meta-heuristic are applied as an alternative to conventional techniques.

**Results:** The problem in hand was reduced to a two-criterion unconstrained extreme problem and solved with different evolution-based multi-objective optimization heuristics. Next, we applied a proposed meta-heuristic combining the particular algorithms and causing their interaction in a cooperative and collaborative way. The obtained results showed that the island heuristic outperformed the original ones based on the values of a specific metric, thus showing the representativeness of Pareto front approximations. Having more representative approximations, decision-makers have more alternative project portfolios corresponding to different risk and profit estimations. Since these criteria are conflicting, when choosing an alternative with an estimated high profit, decision-makers follow a strategy with an estimated high risk and vice versa.

**Conclusion:** In the present paper, the project portfolio decision-making problem was reduced to a 0-1 knapsack constrained multi-objective optimization problem. The algorithm investigation confirms that the use of the island meta-heuristic significantly improves the performance of genetic algorithms, thereby providing an efficient tool for Financial Responsibility Centres Management.

**Keywords:** 0-1 multi-objective constrained knapsack problem; project management portfolio problem; multi-objective evolution-based optimization algorithms; collaborative and cooperative meta-heuristics

## 1 Introduction

When managing an organization, many different kinds of problems can be faced and a large proportion of these can be solved mathematically. These problems are actually decision-making problems in the space of alternatives and thus can be reduced to mathematical programming problems in which a solution that provides an extremum value of some criterion is a decision. The aim of decision-making support systems is to solve these mathematical programming problems so that managers could base their decisions on numerical analysis performed by the program software. This means that a computational system which supports the decision-making process for top managers in the project management problem is important, useful and its application provides a mathematically determined solution. In this paper, we focus on the problem, which takes place in machine-building factory management, where the project investment problem should be solved. According to this, we need to allocate funds among different financial responsibility centres.

In this study, we consider the two-objective knapsack problem, which is in some way similar to a real investment portfolio management problem for a factory. Here a factory, considered as a system, contains different subsystems with their specific products, functionality and properties. In big companies, there are many innovative projects aimed at modernizing technology, thus increasing income, reducing the amount of work in progress and making the business more client-oriented. Therefore, by solving this problem, it becomes possible to reduce the time spent by top managers on making decisions – their projects should be accepted and realized in the near future. It is important and should be highlighted that the characteristics of each subsystem and the complexity of project domains prevent people from being experts in all areas and, consequently, from making a properly weighted and informed decision. This explains the importance and the value of decision-making support systems with a growing focus on algorithms solving related problems.

The problem discussed in this paper differs from the ones in Markowitz's (Markovitz, 1952) modern portfolio theory based on mean-variance analysis, and also from those discussed in post-modern portfolio theory (Rom and Ferguson, 1993). It has the form of the decision-making multi-objective optimization problem, specifically, the two-criterion 0-1 knapsack optimization problem with constraints. The growing complexity, which is caused by growth in the problem dimensionality, nonlinearities, the specific nature of alternatives' representations and the multimodality of criteria, requires new algorithms which allow these difficulties to be overcome. Such algorithms are so-called evolution-based and nature-inspired techniques – stochastic optimization algorithms modified by many researchers to deal with complex problems. These mod-

ifications change the algorithm operators, the algorithm structure or the meta-heuristics controlling the behaviour of the extremum-seeking algorithm.

There are many different approaches proposed for solving those portfolio problems in which various modifications are implemented. One of them is based on genetic algorithms (Goldberg, 1989) and an entropy-based modification (Aslan et al., 2015) which finds a solution in mean-variance terms. In the study (Drezewski and Doroz, 2017), the multi-agent co-evolutionary approach is applied to a portfolio multi-criteria optimization problem, and the genetic algorithm here is the main optimization technique. A combination of a genetic algorithm and particle swarm optimization (Kennedy and Eberhart, 1995) for solving this kind of problems is considered in (Kuo and Hong, 2013). The results of these investigations show that meta-heuristics greatly improve the performance of the algorithm.

Multi-objective knapsack optimization problems are still of vital importance. Many different approaches are applied, combined and developed for solving these problems which arise from decision-making problems of different backgrounds in various organizations. In the paper (Vianna and Vianna, 2013) a specific optimization algorithm based on a greedy-randomized adaptive search procedure (Feo and Resende, 1995) and a multi-objective iterated local search is proposed. In this work, many different multi-objective optimization methods were presented and one of them was the Chebyshev-based modification of a genetic algorithm (Alves and Almeida, 2007). In the study (Florios et al., 2010) some different approaches based on genetic algorithms were investigated for solving the considered problem.

In this study, we compare some cooperative approaches with homogenous and heterogeneous combinations joined in the island model for solving the project management decision-making problem for a machine-building factory. The experimental results prove that the proposed meta-heuristics outperform standard multi-criteria optimization algorithms.

## 2 Project Portfolio and 0-1 Knapsack Multi-Criteria Problem

One of the common ways of alternative space representation in the 0-1 knapsack problem, related to project portfolio management, is the Boolean space  $B^n$ , where  $n$  is a space dimension and is equal to the number of projects. In other words, the way the knapsack is packed (portfolio of projects), is a Boolean vector  $x \in B^n$  in which coordinates are decisions on each project: it is 0 or *false* if we decline the project realization and it is 1 or *true* if we accept the project. In this study, we consider an organization which structurally consists of  $m$  financial responsibility centres

(FRC) and there are

$$N_j, j = \overline{1, m}$$

different projects for each FRC. The whole number of projects

$$n = \sum_{j=1}^m N_j$$

determines the dimensionality of the Boolean space.

In this decision-making problem, the  $j$ -th project of  $i$ -th FRC has the following characteristics:  $c_{i,j}$  denotes the annual costs of the project realization,  $R_{i,j}$  is an expert's estimation of its realization risks and  $P_{i,j}$  is the annual profit of the project if it is accepted. The whole organization also has its own characteristics:  $C$  is the total amount of credits, which is normally a sum of  $C_p$ , the annual credits of each FRC for project realizations and  $\hat{C}$ , which is the same for the whole organization. We may also require the specific rate of return on capital  $r$  to be satisfied.

This problem definition leads to a pseudo-Boolean optimization problem with two criteria and inequality constraints. The first criterion is the maximization of the profit of all the accepted projects and the second criterion is the minimization of the sum of the risks. As can be seen, the first criterion is to be maximized, and the second – minimized:

$$F_1(x) = \sum_{i=1}^m \sum_{j=1}^{N_i} P_{i,j} \cdot x_{I(i,j)} \rightarrow \max_{x \in B^n}, \quad (1)$$

$$F_2(x) = \sum_{i=1}^m \sum_{j=1}^{N_i} R_{i,j} \cdot x_{I(i,j)} \rightarrow \min_{x \in B^n}, \quad (2)$$

where

$$I(i, j) = \sum_{k=0}^{i-1} N_k + j, N_0 = 0$$

is a specific indexing function which returns the index of a Boolean vector for the  $j$ -th project of the  $i$ -th FRC.

At the same time, the project portfolio must satisfy the constraints. We cannot exceed the amount of credits and we cannot go below the current return rate on capital:

$$B_1(x) = \sum_{i=1}^m \sum_{j=1}^{N_i} c_{i,j} \cdot x_{I(i,j)} \leq C, C = \sum_{i=1}^m C_i + \hat{C}, \quad (3)$$

$$B_2(x) = F_1(x) / B_1(x) \geq r. \quad (4)$$

To reduce the constrained extremum-seeking problem (1)-(4) to an unconstrained one, we use the static penalty functions:

$$F_p(z) = \begin{cases} z & \text{if } z > 0, \\ 0 & \text{if } z < 0, \end{cases} \quad (5)$$

and the initial problem can be determined with the formulas:

$$\hat{F}_1(x) = F_1(x) - \alpha_{1,1} \cdot F_p(B_1(x) - C) - \dots - \alpha_{1,2} \cdot F_p(B_2(x) - r) \rightarrow \max_{x \in B^n}, \quad (6)$$

$$\hat{F}_2(x) = F_2(x) + \alpha_{2,1} \cdot F_p(B_1(x) - C) + \dots + \alpha_{2,2} \cdot F_p(B_2(x) - r) \rightarrow \min_{x \in B^n}, \quad (7)$$

where positive numbers

$$\alpha_{i,j}, i, j = \overline{1, 2}$$

are the controlling parameters. In this study, we set all the parameters equal to  $\alpha = 10^3$ .

The considered problem (6) and (7) is known to be NP-hard so there is no time and computational-efficient optimization technique that would find a global optimum. This becomes further complicated when we need to find the set of solutions which approximates the Pareto set. As was mentioned earlier, we need a specific optimization technique which is efficient in solving this kind of problem, and for this purpose we use modern multi-objective algorithms and improve them with the island meta-heuristic (Preuss, 2015).

### 3 Multi-Objective Genetic Algorithms and the Island Model Meta-Heuristic

The common scheme of any multi-objective genetic algorithm (MOGA) includes the same steps as any conventional one-criterion GA (Crainic and Toulouse, 2010):

- 1 *Generate the initial population*
- 2 *Evaluate criteria values;*
- 3 *Estimate fitness-values;*
- 4 *While (stop-criterion!=true), do:*  
 $\{$
- 5 *Choose the most appropriate individuals with the mating selection operator based on their fitness-values;*
- 6 *Produce new candidate solutions with recombination;*
- 7 *Modify the obtained individuals with mutation;*
- 8 *Evaluate criteria values for new candidate solutions;*
- 9 *Estimate fitness-values;*
- 10 *Compose the new population (environmental selection);*  
 $\}$

When designing a MOGA, researchers are faced with some issues relating to fitness assignment strategies, diversity preservation techniques and ways of elitism implementation. Therefore, we will consider the effectiveness of MOGAs which are based on various heuristics. *Non-Sorting Genetic Algorithm II (NSGA-II)* (Deb et al., 2002), *Preference-Inspired Co-Evolutionary Algorithm with goal vectors (PICEA-g)* (Wang, 2013) and *Strength Pareto Evolutionary Algorithm 2 (SPEA2)* (Zitzler et al., 1997) are used as tools to optimize the introduced criteria. The basic features of each method are displayed in Table 1.

However, it is almost impossible to know in advance which algorithm is the most effective for the current problem. On the one hand, a series of experiments might be conducted to find the best MOGA, which is quite a time-consuming approach. On the other hand, different algorithms might be combined in a cooperation to avoid having to choose the most effective one. In reality, this kind of modification is easily implemented and is based on an island model.

The *island model* (Whitley et al., 1997) of a GA implies the parallel work of several algorithms: they might

Table 1: Basic features of the MOGA used

MOGA	Fitness Assignment	Diversity Preservation	Elitism
NSGA-II	Pareto-dominance ( <i>niching mechanism</i> ) and diversity estimation ( <i>crowding distance</i> )	Crowding distance	Combination of the previous population and the offspring
PICEA-g	Pareto-dominance ( <i>with generating goal vectors</i> )	Nearest neighbour technique	The archive set and combination of the previous population and the offspring
SPEA2	Pareto-dominance ( <i>niching mechanism</i> ) and density estimation ( <i>the distance to the k-th nearest neighbour in the objective space</i> )	Nearest neighbour technique	The archive set

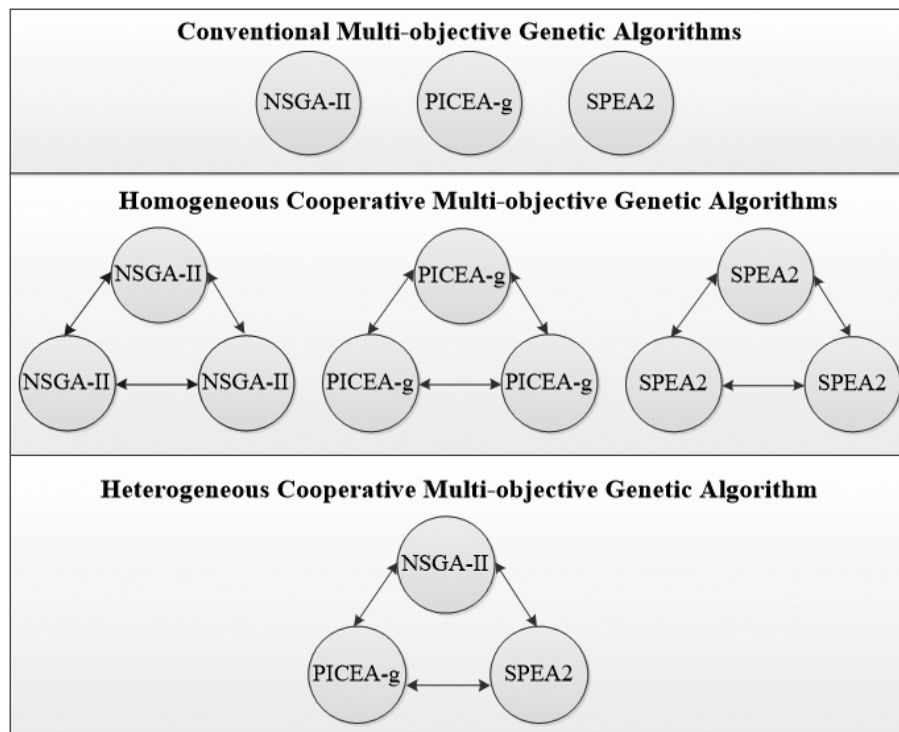


Figure 1: The three categories of algorithms used



be the same or different. The initial number of individuals  $M$  is spread across  $L$  subpopulations:  $M_i = M/L$ ,  $i=1, \dots, L$ . At each  $T$ -th generation, algorithms exchange the best solutions (*migration*). There are two parameters: *migration size*, the number of candidates for migration, and *migration interval*, the number of generations between migrations. It is also necessary to define the island model topology, in other words, the scheme of migration. We use fully connected topology, meaning that each island shares its best solutions with all the other islands included in the model. This multi-agent model is expected to preserve a higher level of genetic diversity.

Firstly, the conventional NSGA-II, PICEA-g, and SPEA2 have been implemented to be used as optimizers (Figure 1 top).

Secondly (Figure 1, middle), we have achieved a number of *homogeneous* cooperative algorithms: in each case, the island model has the same three components: they are NSGA-II, PICEA-g or SPEA2. In addition to diversity preservation, another benefit of this model is the possibility to reduce the computational time due to the parallel work of islands.

Finally, a *heterogeneous* cooperative algorithm has been developed (Figure 1, bottom). Three different MOGAs (NSGA-II, PICEA-g and SPEA2) have been included in this model as its components simultaneously. The benefits of the particular algorithm (NSGA-II, PICEA-g or SPEA2) could be advantageous at different stages of optimization (Brester and Semenkin, 2015).

In summary, there are three main categories of MOGAs which are used in this study and they are portrayed in Figure 1.

## 4 Statistical Investigations

The problem in question was solved for a big machine-building plant. There were five FRC ( $m = 5$ ) and each FRC had its own list of projects and required investments ( $N_1 = 8, N_2 = 6, N_3 = 5, N_4 = 3, N_5 = 3$ ).

$$\sum_{j=1}^m N_j = 25$$

For each of the projects, we had an expert's estimations of the risks  $R_{i,j}$  and annual profits  $P_{i,j}$ . The whole number of projects  $n$  was equal to

hence in this knapsack problem we had 25 Boolean variables. Other parameters were set as follows:  $\hat{C} = 40, r = 0.5$ .

Firstly, we used an exhaustive search to design a true Pareto front. It required  $2^{25} = 33554432$  vector-function evaluations. In Figure 2, the obtained front is presented. It might be noted that the dependence between the  $F_1$  - (6) and  $F_2$  - (7) criteria is close to linear. Increasing the profit would cause an increasing in the risk, and minimizing the

risk leads to a decrease in profit.

It is essential to note that for an exhaustive search, an increase in the problem dimensionality leads to the exponential growth of vector-function evaluations. Therefore, for high-dimensional problems, it might be time-consuming and some alternative methods should be developed.

Next, we applied the conventional NSGA-II, PICEA-g and SPEA2 to solve the problem. In all the experiments, we defined the following settings: binary tournament selection, uniform recombination and the mutation probability  $p_m = 1/L$ , where  $L$  is the length of the chromosome. A series of tests with different amounts of resources was conducted: Exp. 1 – 100 individuals and 200 generations (20,000 vector-function evaluations), Exp. 2 – 200 individuals and 300 generations (60,000 vector-function evaluations), Exp. 3 – 300 individuals and 400 generations (120,000 vector-function evaluations). To estimate the quality of the obtained approximations of the true front, we

$$IGD(P^*, A) = \frac{\sum_{v \in P^*} d(v, A)}{|P^*|} \quad (8)$$

involved *Inverted Generational Distance* (IGD) (8), which equates the average distance from the true Pareto front  $P^*$  to the found solution  $A$  (Zhang et al., 2008):

where  $d(v, A)$  is the minimum Euclidean distance between  $v$  and the points in  $A$ .

All the results were averaged over 25 runs of each algorithm. Table 2 contains the averaged IGD values corresponding to three experiments (Exp. 1, 2 and 3) and three conventional MOGAs (NSGA-II, PICEA-g and SPEA2).

By increasing the amount of resources, we obtain approximations which are getting closer to the true front. In two cases (for PICEA-g and SPEA2), we may see a great improvement of IGD values caused by the growth of vector-function evaluations. For NSGA-II, increasing the amount of resources by a factor of two does not lead to a significant improvement (from 20,000 up to 60,000) or to any improvement (from 60,000 up to 120,000). The algorithm which was the best for the lowest number of vector-function evaluations (Exp. 1) was the worst for the highest number of calculations (Exp. 3).

To illustrate the obtained solutions, from each experiment we chose one Pareto front approximation corresponding to the median value of IGD. In Figure 3, we depict these approximations.

Then, we applied three homogeneous cooperative MOGAs: NSGA-II – NSGA-II – NSGA-II, PICEA-g – PICEA-g – PICEA-g and SPEA2 – SPEA2 – SPEA2. For each MOGA, all islands had an equal amount of resources (200 generations and  $300/3 = 100$  individuals in populations), the migration size was equal to 20 (in total, each island received 40 points from two others), and the migration interval was equal to 20 generations. Thus, in this experiment the amount of resources corresponded to the

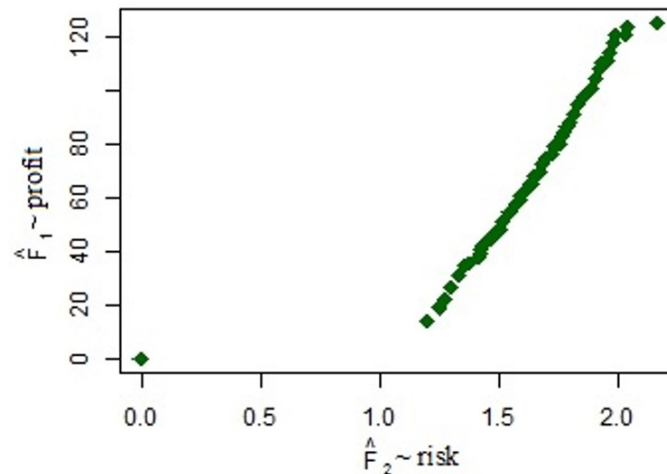


Figure 2: The true Pareto front for the real problem considered

Table 2: Experimental results. IGD values for the conventional MOGAs

MOGA	IGD values		
	Exp. 1 (20,000 eval.)	Exp. 2 (60,000 eval.)	Exp. 3 (120,000 eval.)
NSGA-II	0.5520	0.4664	0.4838
PICEA-g	0.9649	0.5598	0.3564
SPEA2	0.7352	0.4423	0.2822

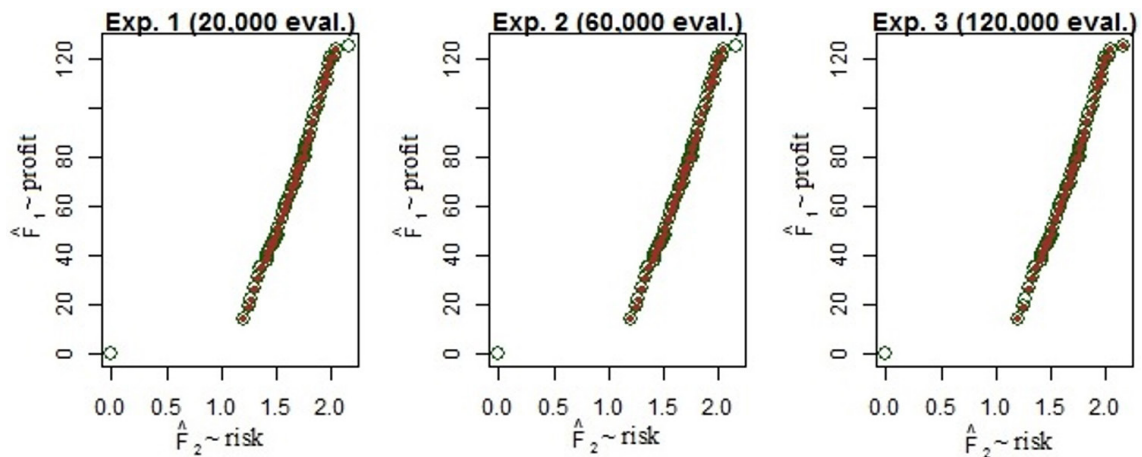


Figure 3a: The Pareto front approximations obtained by NSGA2

number of vector-function evaluations in Exp. 2 (60,000). We also estimated the averaged IGD values and presented them in Table 3. It might be noted that the use of the island model led to a considerable improvement in IGD values. Moreover, having the same amount of resources as we had in Exp. 2, we could achieve IGD values which were comparable with (for PICEA-g and SPEA2) or even better (for NSGA-II) than we gained in Exp. 3.

Finally, the heterogeneous MOGA (NSGA-II – PICEA-g – SPEA2) was used to solve the problem in question. Again, we provided the algorithm with 60,000 vector-function evaluations. All the other settings were also the same (as for homogeneous cooperative MOGAs). The averaged IGD value obtained by the heterogeneous cooperative MOGA is equal to the best averaged IGD value achieved by the homogeneous cooperative MOGA (Table

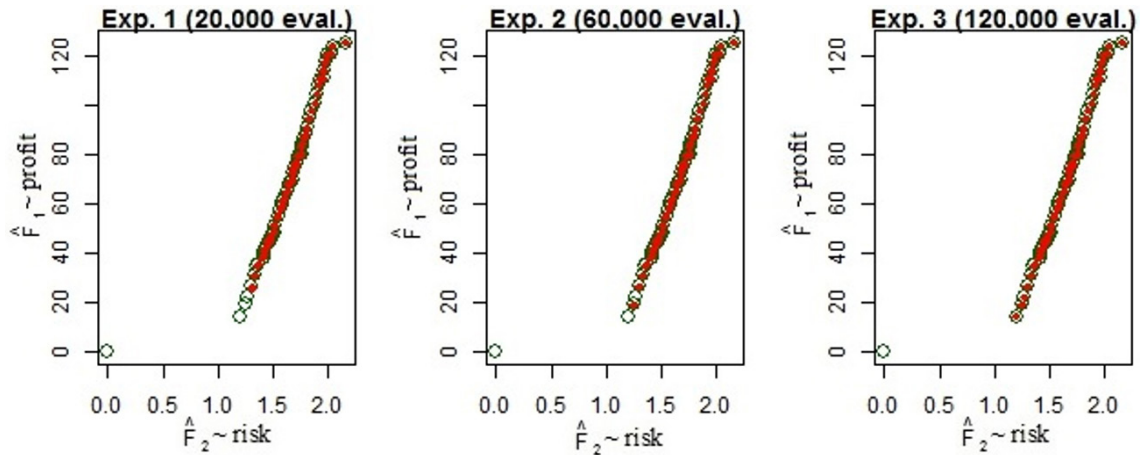


Figure 3b: The Pareto front approximations obtained by PICEA-g

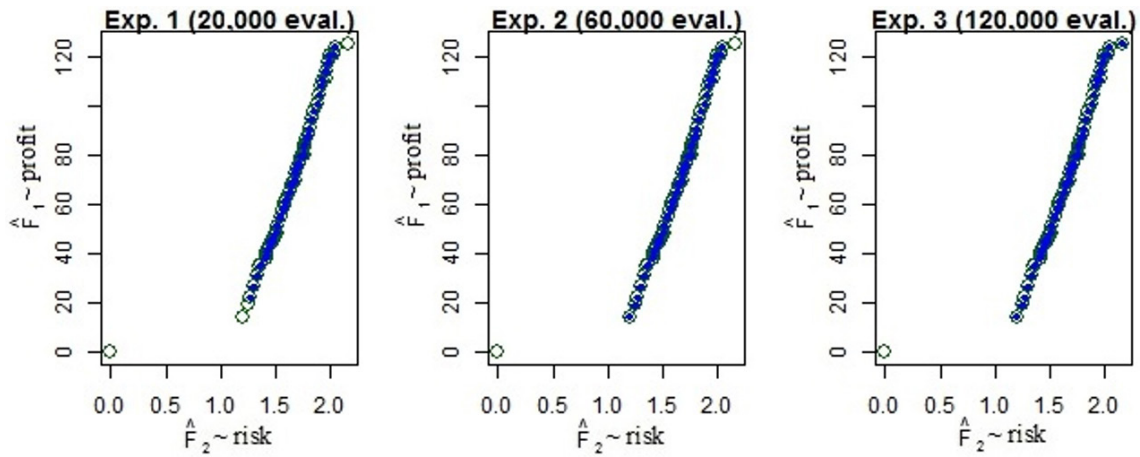


Figure 3c: The Pareto front approximations obtained by SPEA2

Table 3: Experimental results. IGD values for the cooperative MOGAs

IGD values	
<i>Homogeneous cooperative MOGAs</i>	
NSGA-II – NSGA-II – NSGA-II	0.2985
PICEA-g – PICEA-g – PICEA-g	0.4153
SPEA2 – SPEA2 – SPEA2	0.3876
<i>Heterogeneous cooperative MOGA</i>	
NSGA-II – PICEA-g – SPEA2	<b>0.2984</b>

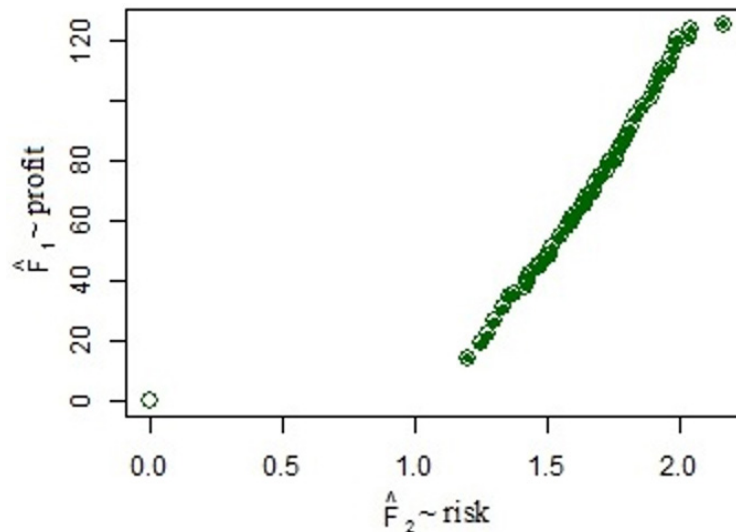


Figure 4. The Pareto front approximation obtained by the heterogeneous MOGA

3). It is also comparable with the best result in Exp. 3 (with 120,000 vector-function evaluations).

In Figure 4, we show one Pareto front approximation found by the heterogeneous cooperative MOGA and corresponding to the median value of IGD.

The results obtained proved the effectiveness of cooperative MOGAs: firstly, with the same amount of resources we could attain much better IGD values and, secondly, using the heterogeneous cooperative MOGA, we could avoid having to choose the most appropriate MOGA for the current problem (it is essential because MOGAs demonstrate different performances in Exp. 1, 2 and 3).

As one can see, the estimated Pareto front provides decision-makers with possible outcomes, in case they consider multiple criteria, and enables them to choose the combination, which would fit the current state of the market. The proposed heterogeneous island approach also provides faster convergence toward the solutions.

## 5 Conclusion

In this study, we focused on the decision-making problem related to machine-building factory portfolio management with the goal of optimal investment, which can be defined as the 0-1 multi-objective constrained knapsack optimization problem. This problem is NP-hard, the criteria are mappings from the Boolean space and we need to estimate the Pareto front on a set of permissible alternatives. To reach the goal, an efficient multi-objective optimization technique is required.

We applied well-known evolution-based algorithms such as PICEA-g, SPEA2 and NSGA-2 for this problem with different amounts of resources. The algorithms were

compared using the specific IGD metric, which is a common measure of Pareto front representativeness. As can be seen, increasing the computational resources usually yielded an increase in the efficiency of the algorithm and, with the exception of NSGA2, the increase is significant. Hence, adding more resources may improve the results, though the effect is unpredictable and non-linear. Moreover, in the case of NSGA2 being applied to this problem, the median of the IGD metric was not improved after 60,000 evaluations and this is probably a result of the algorithm behaviour.

To overcome this obstacle, we used an island model based on the interaction among multi-objective optimization algorithms: homogeneous, when the algorithms are of the same nature, and heterogeneous, when the algorithms are different. Experimental results show that the developed approach outperforms the original algorithms even with the lower amount of computational resources. The most efficient algorithms are the following: the heterogeneous algorithm with the SPEA2, NSGA-2 and PICEA-g combination and the homogeneous algorithm with three NSGA-2. This implies that the island model-based multi-objective algorithms are more efficient and more promising in solving the complex NP-hard problems of organizational management.

The proposed approach provides us with a set of non-dominated alternatives, which are project portfolios with different profits and risks. This solution is valuable for top managers when they make decisions on future investments based on the current state of the whole organization and estimations of project characteristics. More profitable project portfolios usually have a high level of risks and less profitable project portfolios correspond to a low level of risks. The main benefit of applying the pro-

posed approach is its flexibility and ability to show the bigger picture. Whatever risk value is confirmed by the decision-maker, the Pareto set approximation gives the best portfolio in terms of the profit and vice versa.

Our proposal is going to be investigated on higher-dimensional similar problems with nonlinear profit functions, since most of the projects are related and affect each other. This is the first possible direction of our research in the near future. Following this, it would be reasonable to solve similar problems with stochastic uncertainties as is considered in modern portfolio theory where risks and profits are the stochastic variables.

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## Algoritmi za optimizacijo več ciljev z metaheuristiko otoka za učinkovito reševanje problema vodenja projektov

**Ozadje in namen:** V vsaki organizaciji vodenje projektov odpira številne in različne probleme odločanja, katerih velik del je mogoče učinkovito rešiti s pomočjo posebnih sistemov za podporo odločanju. Takšni problemi vedno predstavljajo izziv, saj za njihovo kompleksnost ni časovno ali računsko učinkovitega algoritma. V članku obravnavamo problem optimalnih finančnih naložb. V naši rešitvi upoštevamo naslednje organizacijske vire in značilnosti projekta: dobiček, stroške in tveganja.

**Zasnova / metodologija / pristop:** Problem odločanja je formuliran kot večkriterialni problem 0-1 nahrbtnika. To pomeni, da moramo poiskati nedominantno množico alternativnih rešitev kot kompromis med maksimiranjem dohodkov in zmanjševanjem tveganj. Obenem pa morajo alternative zadoščati omejitvam. To vodi k omejenemu problemu dvokriterialne optimizacije v Boolovem prostoru. Da bi obvladali posebnosti in visoko zapletenost problema, smo kot alternativo običajnim tehnikam uporabili evolucijske algoritme z meta-heuristiko otoka.

**Rezultati:** Problem smo formulirali kot neomejeno dvokriterijsko optimizacijo in ga rešili z različnimi heurističnimi optimizacijami, ki temeljijo na evoluciji. Nato smo predlagali meta-heuristiko, ki združuje specifične algoritme in dosega njihovo interakcijo na sodelovalni način. Dobljeni rezultati so pokazali, da je heuristika otoka preseгла rezultate, dobljene na podlagi vrednosti specifične metrike, s čimer se je pokazala reprezentativnost Paretovih prednjih aproksimacij. Bolj reprezentativni približki omogočajo nosilec odločanja več alternativnih projektnih portfeljev, ki ustrezajo različnim ocenam tveganja in dobička. Ker so ti kriteriji v nasprotju, pri izbiri alternative z ocenjenim visokim dobičkom nosilci odločanja sledijo strategiji z ocenjenim tveganjem in obratno.

**Zaključek:** V članku smo problem reševanja portfeljev projektov formulirali kot problem večciljne optimizacije 0-1 nahrbtnika z omejitvami. Analiza algoritma potrjuje, da uporaba meta-heuristike otoka bistveno izboljšala učinkovitost genetskih algoritmov in tako predstavlja učinkovito orodje za upravljanje centrov za finančno odgovornost.

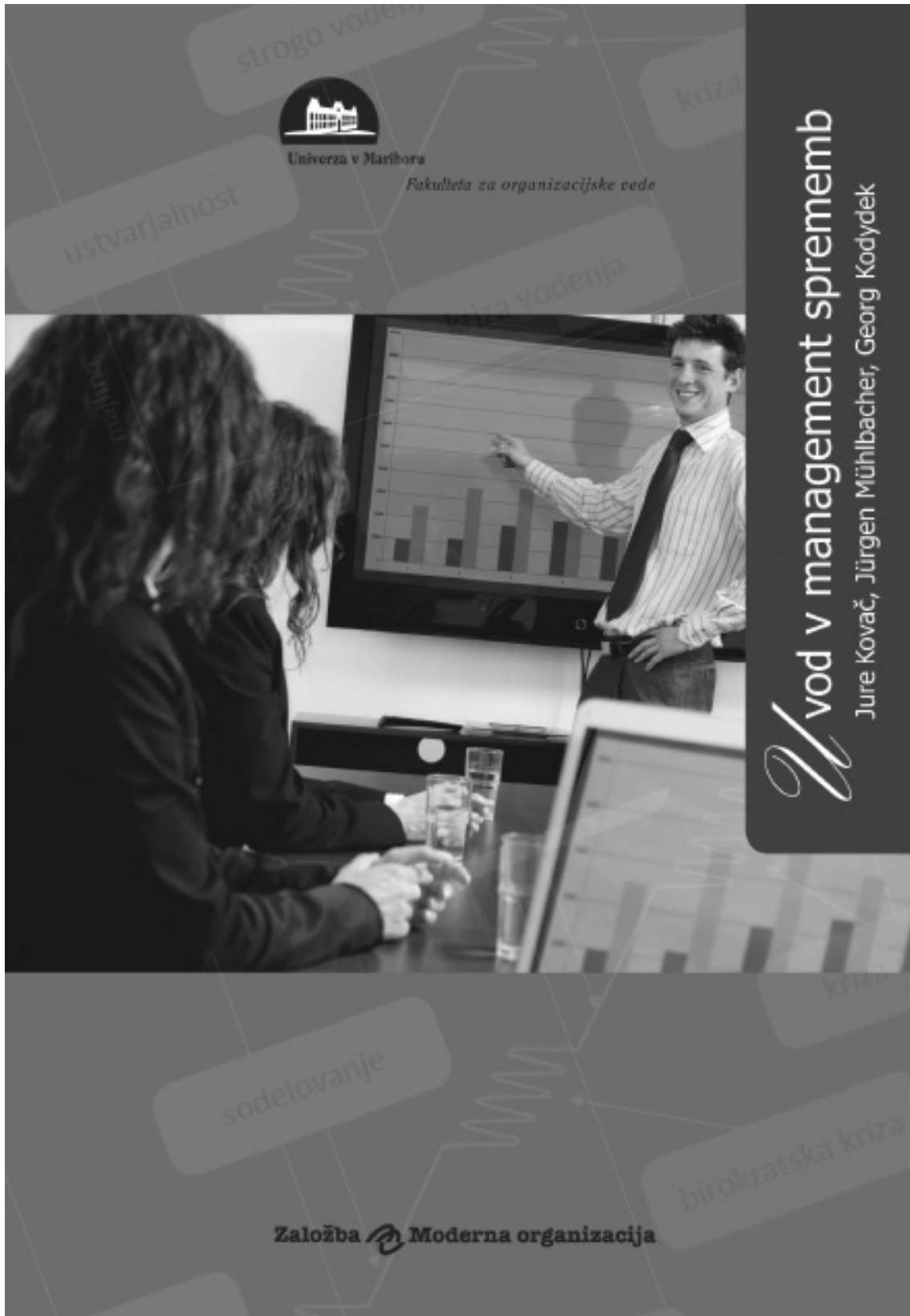
**Ključne besede:** 0-1 večkriterialni problem nahrbtnika; portfelj vodenja projektov; večciljni evolucijski algoritmi za optimizacijo; skupna in kooperativna meta-heuristika

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