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Influence of individual and organisational variables on the perception of organisational values

Rūta Adamonienė Lienite Litavniece
Laima Ruibytė Evelina Viduolienė

ABSTRACT

A favourable organisational culture founded on the values of employees and organisation leaders must be created to achieve goals, innovate and maintain a well-functioning organisation. Knowing these values and how they are influenced by various factors, such as age, the length of service, and the nature of work, must help to change employee beliefs, norms and behaviour patterns in a way that helps to achieve greater organisational success and efficiency. The study sample size consisted of 172 employees of educational institutions and 242 employees from municipal organisations. Occupational features and occupational behaviour were evaluated using a set of organisational values (Glomseth et al., 2011). The current research aimed (1) to evaluate organisational values and feature dimensions with respect to the inter-institutional level, (2) to evaluate organisational values and feature dimensions and distinguish the most prevalent with respect to the subordination level, (3) to evaluate organisational values and feature dimensions with respect to individual variables (gender, age and the length of occupational experience). The results revealed that task effectiveness, time management and cooperation, employee-orientated behaviour were stronger in educational organisations than municipal. Authoritarian management, formality and restrictions were stronger in municipal rather than educational organisations. Compared to beliefs held by subordinates, superiors claimed that positive organisational values, such as effectiveness, cooperation, and employee-orientated behaviour, were more typical in both types of institutions. Formal communication and restrictions were more typical for employees rather than managers. Subordinates but not superiors tended to perceive and evaluate organisational values, features and behaviour differently depending on gender.

KEY WORDS

organisational values, educational organisation, municipal organisation, subordination level

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Introduction

A value system determines all human activity, including the main line of behaviour. Management theories speak about values as a factor determining the organisation's success (Kraemer & Harry, 2011; Bourne & Jenkins, 2013). Organisational values are a key element of organisational culture; and comprise strategies, goals and philosophies that have a greater depth and influence visible behaviour and create organisational culture as well as its specificity (Schein,

Adamonienė, R., Litavniece, L., Ruibytė, L., & Viduolienė, E. (2021). Influence of individual and organisational variables on the perception of organisational values. *Engineering Management in Production and Services, 13*(2), 7-17. doi: 10.2478/emj-2021-0008

1999, 2010). Organisational culture expresses shared assumptions, values and beliefs, and is the social glue holding an organisation together. An organisation with a strong culture has common values and codes of conduct for its employees, which should help them accomplish their missions and goals (Deal & Kennedy, 2000; Yafang, 2011). A favourable organisational culture founded on the values of employees and organisation leaders must be created to achieve goals, innovate and maintain a well-functioning organisation (Gregory et al., 2009; Cameron & Quinn, 2011). Organisational culture values reflect usual patterns of activity and behaviour typical to employees and are formed by specific management elements, such as organisational structure, goals, procedures, types of promotion, and human resource management practices. Knowing these values and how they are influenced by various factors, such as age, the length of service, and the nature of work, must help to change employee beliefs, norms and behaviour patterns in a way that allows achieving greater organisational success and efficiency. It appears crucial to identify values existing in a given organisation. The question is, do and how they vary depending on the type of organisation they represent? The purpose of this study is to reveal the values of different public organisations, i.e., educational and municipal, and how they are influenced by various factors, such as status, age, length of service and employee gender.

1. Literature review

Values may be defined as personal beliefs and are derived from psychological needs; thus, they can produce states of psychological tension, which lead to cognition, affect and behaviour (Rokeach, 1973, 1979). Values can influence the way an individual perceives and interprets a situation and its importance, impacting reactions and behaviour under certain circumstances. Values occupy a central position in a person's cognitive system; they influence attitudes, decision-making processes and human behaviours (Swartz et al., 2000). Schwartz's (1992) theory suggests basic values recognised by people from all cultures. They are considered universal as they meet at least one of the three basic needs of human existence: biological needs, social interaction needs, and institutional and social needs aimed at a group's welfare (Schwartz et al., 2004, 2012).

The terminology of values was adopted in the field of organisational studies, and it was recognised that organisational values played the same role as personal values, i.e., guiding an organisation's functioning (Schein, 1990). Organisational values reflect what is essential to the organisation or social group to achieve common goals and collective good (Van der Wal, Graaf & Lasthuizen, 2008; Szydło & Grześ-Bukłaho, 2020). They are stable and durable but not fully fixed and particularly connected to the phenomena of culture and institutionalism (Bourne & Jenkins, 2013).

Values are critical in an organisation because the resemblance in their perception makes an organisational culture effective and functional (Weiss, 2001). Perceived organisational values refer to employee beliefs about acceptable or appropriate practices in their organisation (Trevino & Youngblood, 1990). Organisational values are a long-term belief that connects members of the organisation to co-operate and implement the goals of the organisation. The study of organisational values on levels of an individual and a group is essential because this knowledge can help managers understand and predict attitudes towards various organisational outcomes (Meglino & Ravlin, 1998). Values also serve as standards for evaluating employee behaviour and organisational success. Different studies show the relationship between organisational values and individual values (Ros et al., 1999; Meglino & Ravlin, 1998; Martins & Coetzee, 2011; Adamonienė & Ruibytė, 2013; Czerniawska & Szydło, 2020), self-esteem (Naus et al., 2007), ethical behaviour (Jin et al., 2007), organisational commitment (Finelgan, 2000; Abbot et al., 2005) and other important organisational factors (Mcnaughton, 2003; Hendel & Steinman, 2002; Verquer et al., 2003; Vveinhardt & Gulbovaite, 2018; Ohunakin et al., 2019; Okulich-Kazarin, Jasik-Ślęzak & Okulicz-Kozaryna, 2018).

In today's era of rapid changes in societies and increased competition, organisational values cannot remain the same as before because of demanding work conditions and public expectations. Studies show that in the process of organisational transformation, values must be present and operationalised for organisations to successfully change, and leadership must facilitate that change (McNaughton, 2003; Hendel & Steinman, 2003). The core values of an organisation begin with its leadership and subordinates who will be led by these values, so the behaviour of leaders and subordinates should gradually fall in line. A change in an organisation depends on the extent to which leaders are able to convey the desired values necessary to achieve organisational goals (Kraemer, 2011) and the ability to find a balance

between individual and organisational values (Hultman, 2001). Once stable, unified behaviour, values and beliefs are developed, a strong organisational culture emerges. Therefore, it is important to determine the organisational values considered important by the leaders and determine how those values are perceived by their subordinates. Knowing the organisational values of employees, managers can determine whether the organisational values are consistent and meet their corporate goals. Many researchers focusing on the fit between a person and an organisation show that value congruence is favourably related to important work outcomes, i.e., increased job satisfaction, lower attrition, better job performance, ethical behaviour and a strengthened commitment to the organisation (Amos & Weathington, 2008; Casida & Pinto-Zipp, 2008; Denison, Haaland & Goelzer, 2004; Lund, 2003; Ros, Schwartz & Surkiss, 1999; Verquer, Beehr & Wagner, 2003; Gregory et al., 2009; Giedraiti & Stašys, 2019).

An organisation has a different status, age, gender, nationality of workers, whose approach to the organisation's values may differ. Research has shown that such individual features as personality traits, gender, race and age have a significant effect on some organisational values, and these groups differ significantly in their perception of the importance of certain organisational values (Martins & Coetzee, 2011, Paz et al., 2020); therefore, it is necessary to explore and understand the assumptions and reasons of the value perception and acceptance of differences and similarities.

Nowadays, organisations are seen as complex and dynamic systems existing in the world of constant changes and interactions with the environment. New global trends in public policy and administration — the New Public Management (NPM) and managerialism — have had a significant influence on all public organisations. NPM emphasises more efficient public organisations, whereas managerialism describes an ideology of management (Deem & Brehony, 2005); thus, it is thought to cause some controversy in the values of the organisation (Nabatchi, 2011). Evetts (2009) distinguished two concepts when talking about the impact of new management on professional groups and professionalism: organisational professionalism, which manifests as control used by the organisations' managers, and occupational professionalism, which involves collegial authority. Organisational professionalism is integrated with the values and principles of NPM, and managerialism or occupational professionalism is based on professional values and ethics (Evetts, 2009).

There is a great deal of research on the differences in values of private and business organisations (Lyons et al., 2006; van der Val & Huberts, 2008; Beck Jørgensen & Bozeman, 2007), but less research on differences within the public sector (van Thiel & van der Wal, 2009; Szydło, 2016).

This study seeks to clarify the existing organisational values of two types of public organisations — municipal and educational — and explore the influence of personal variables (gender, age and work experience) and organisational variables (subordination) on the congruence of basic organisational values and beliefs. This is essential because only clearly defined and identified values become the management tool to better target the desired employee behaviour. To achieve organisational effectiveness, leaders must know the powerful forces of these cultural traits and learn how to implement strategies to reshape the culture and influence organisational outcomes. Therefore, the research aims (1) to evaluate organisational values and feature dimensions with respect to the inter-institutional level, (2) to evaluate organisational values and feature dimensions and distinguish the most prevalent with respect to the subordination level, and (3) to evaluate organisational values and feature dimensions with respect to individual variables (gender, age and the length of occupational experience).

2. Research methods

The set of organisational values by Glomseth et al. (2011) was used to evaluate occupational features and occupational behaviour in the survey. The researchers classified organisational values and surveyed police managers. The questionnaire consisted of 21 bipolar values that represented organisational culture (a total of 42 items related to organisational features and the behaviour model). It was also found suitable for studying values of educational and municipal organisations and was used purposely to get data comparable between different kinds of organisations (Adamonienė & Ruibytė, 2013, 2014; Adamoniene, Ruibyte & Viduoliene, 2017). Making the scale of values for educational institutions, the authors added five statements reflecting issues of a learning organisation (Adamonienė & Ruibytė, 2016). For every 21 groups of values, two propositions were formulated, e.g., the dimension "Changes/Traditions": a) People are open to change and new activities, b) Traditional and time-tested work meth-

Tab. 1. Three-factor solution of the organisational values and features

Effectiveness and cooperation dimension	Employee orientation dimension	Formality and restrictions dimension
• Staff members are open to change and new activities; • Employees seek to meet work objectives in collaboration with others; • Initiative and personal contribution are supported; • Staff members are given autonomy in their work; • Employees have a clear definition of what needs to be done; • Everyone is trying to achieve or exceed personal results; • The organisation prefers a clear vision and priorities; • Employees in different departments exchange information, knowledge and experience; • Working hours are effectively planned; • At work, the most important goal is to achieve good performance and improve professional skills; • Long-term performance goals and measures for achieving them are formulated and explained; • People openly share personal information; • Different groups of people collaborate; • Clear deadlines for tasks are outlined; • New theoretical knowledge and techniques are used and assimilated to improve performance; • Performing their duties, staff members comply with laws and ethical standards	• Leaders are open to employees of all levels; • Employees are objectively, fairly and adequately evaluated based on results; • The organisation cares for staff development; • Conflicts are analysed and constructively resolved; • Everyone focuses on good friendly relationship in the team; • Creative thinking is encouraged in the organisation or workplace; • Traditional and time-tested work methods are important for work; • To ensure the safety of employees, the organisation analyses situations, plans and develops skills; • Everyone receives financial or other compensation for their results; • Tends to respond to expectations of the public and makes in work-related changes; • To achieve greater efficiency and productivity, they are allowed discretion	• There are many restrictions and controls; • Power and management are in the hands of several individuals or groups; • Communication is rather formal and defined by rules; • People obey leaders unconditionally; • It is more important to take care of your health, family and leisure than to indulge in work; • People do not show their real thoughts and feelings; • Communication is formal and business-like; • Employees are interested in short-term objectives and do not see prospects; • Deny or conceal adverse information from the public; • Individuals deal with work situations and problems solely on the basis of practical experience and knowledge; • Nobody bears responsibility for errors, so they keep recurring; • Focus on practical skills and standard methods of operation; • Strategy objectives and priorities are changed regularly

ods are important for work; the dimension "Individual competition/Cooperation": a) Different groups of people collaborate, b) Everyone is trying to achieve or exceed personal results.

Dimensions and organisational features are presented in articles by Glomseth, Gottschalk and Hole (2011) and Adamoniene, Ruibyte, Viduoliene (2017). Respondents had to evaluate each cultural feature using a 5-point scale (1 — strongly disagree that the feature is typical in my organisation, 5 — strongly agree that the feature is typical in my organisation) to indicate the extent to which the statements about the values were accurate in their organisation.

The survey performed a factorial analysis to extract specific dimensions of organisational features (the principal components method with Varimax rotation). The factorial analysis suggested three dimensions (Kaiser–Meyer–Olkin measure 0.957; Bartlett's test of sphericity 10639.38, $p<0.001$; the three factors explain the cumulative 48.75% of total variance). The score for the "Effectiveness and cooperation" dimension is the average of 16 items and represents effective time management, openness to positive change, collaboration and initiative at work (Cronbach's $\alpha=0.934$; items presented in Table 1). The score for the "Employee orientation" dimension can be computed as an average for 11 items, presented in Table 1. This dimension assesses the attitude of a manager towards an employee, the level of attention given to staff development, the encouragement of autonomy and creative thinking, and the fairness in the evaluation of work results (Cronbach's $\alpha=0.914$). 13 items comprise the "Formality and restrictions" dimension and evaluate the level of authority and power available to superiors, the tendency of employees to obey leaders; they also represent control and

many restrictions, and only formal communication with co-workers (Cronbach's α=0.855). Higher scores of these dimensions indicate high levels of constructs measured by each scale.

Sample and methods. Representatives of educational organisations (N=172) and municipal institutions (N=301) participated in a cross-institutional study. Participants were asked to answer questions concerning organisational features typical to their institutions and provide details regarding demographics and work performance. The questionnaires were anonymous, invitations with a link to the web-based questionnaire were distributed via email.

In educational institutions, the study involved 172 respondents from Kaunas city schools. 151 respondents were female (88.8%), and 19 were male (11.2%, two participants did not indicate their gender). By age, the distribution of respondents was as follows: 6.5% were in the age group of 25–35 years, 21.1% — 36–45, 46.5% — 46–55, 24.7% — 56–65, and 11.2% — more than 66. The distribution of seniority showed that the dominant part of respondents (70.9%) worked at a school for more than 20 years and 19.8% — from 11 to 20 years. 64.7% worked as teachers, and 35.3% were principals.

Among participants of municipal institutions, 242 (80.4%) respondents were female, and 59 (19.6%) were male. 16.9% of professionals from municipal institutions were younger than 36 years, 20.3% — 36–45, 36.2% — 46–55, 26.6% — 56 and elder. The distributions according to the management level was as follows: 71 (23.6%) respondents were executive managers, and 230 (76.4%) — specialists.

Analyses of results were performed using SPSS 22.0. The following statistical methods were used: descriptive analyses, factorial and reliability analysis, Mann–Whitney test for independent samples and Friedman's two-way analysis of variance by ranks for dependent samples, Spearman's ρ correlation coefficient. Non-parametric tests were used because parametric assumptions for data distribution were violated (Kolmogorov-Smirnov tests $p<0.05$).

The authors performed a comparative analysis of non-parametric tests for non-normal distributions of dimension scores and central measures (means) presented in figures to be comparable with other surveys.

3. Research results

Boxplots and descriptive statistics for variables of dimensions "Effectiveness and cooperation", "Employee orientation", and "Formality and restrictions" for educational and municipal organisations are presented in Fig. 1. Participants from educational organisations stated that "Effectiveness and cooperation" (Mann-Whitney statistics -5.120, $p<0.001$) and "Employee orientation" (Mann-Whitney statistics -7.094, $p<0.001$) were more common features and occupational behaviour in their organisations compared to participants of municipal institutions. Participants of municipal institutions claimed that formal

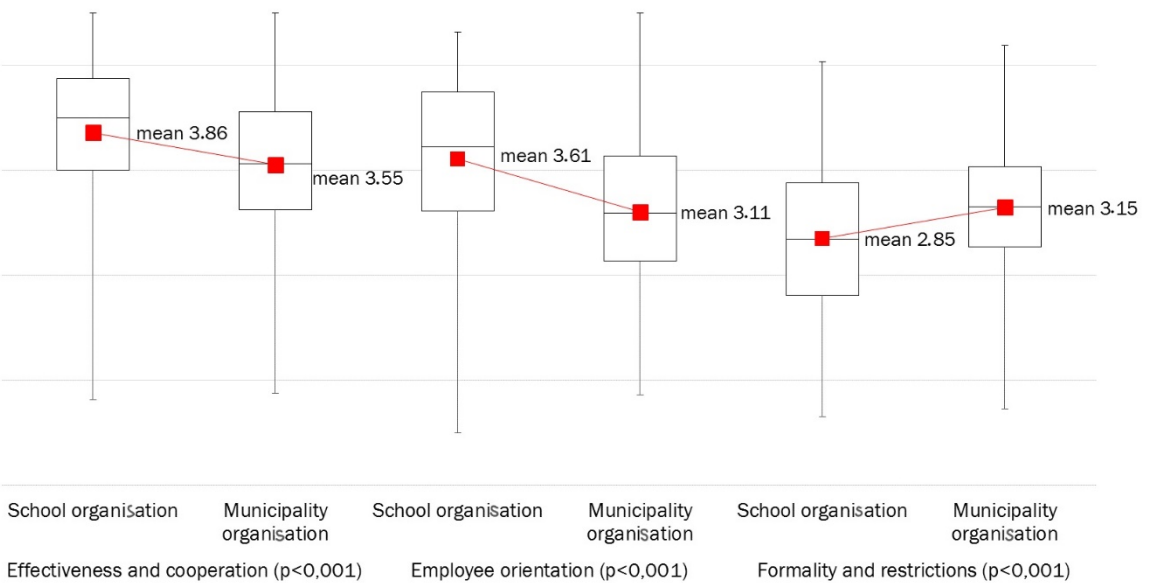

Fig. 1. Comparisons of respondents from educational and municipal institutions based on variables of dimensions "Effectiveness and cooperation", "Employee orientation", and "Formality and restrictions"

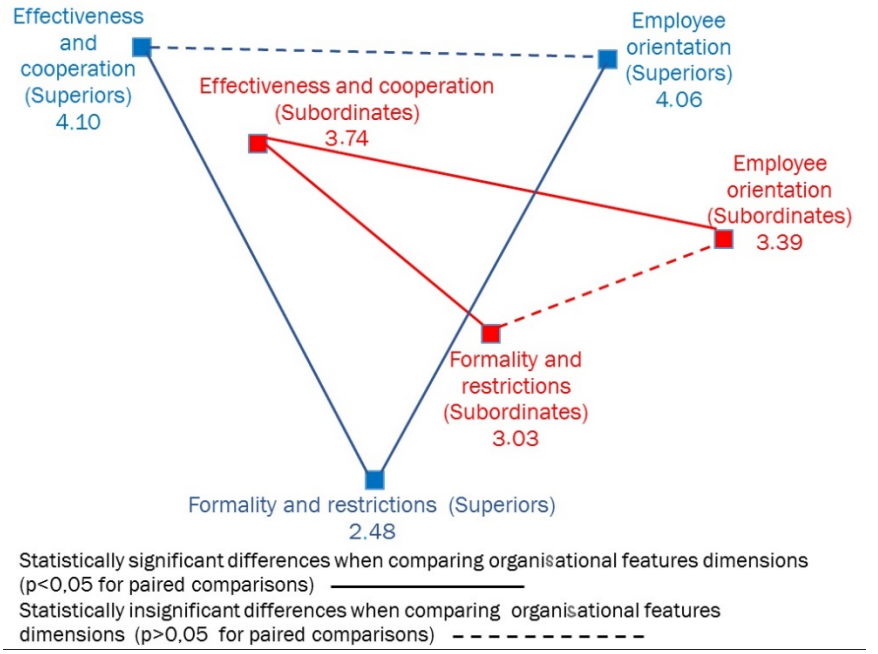

Fig. 2. Intra-institutional and subordination level comparisons of mean scores for different organisational feature dimensions: educational organisations

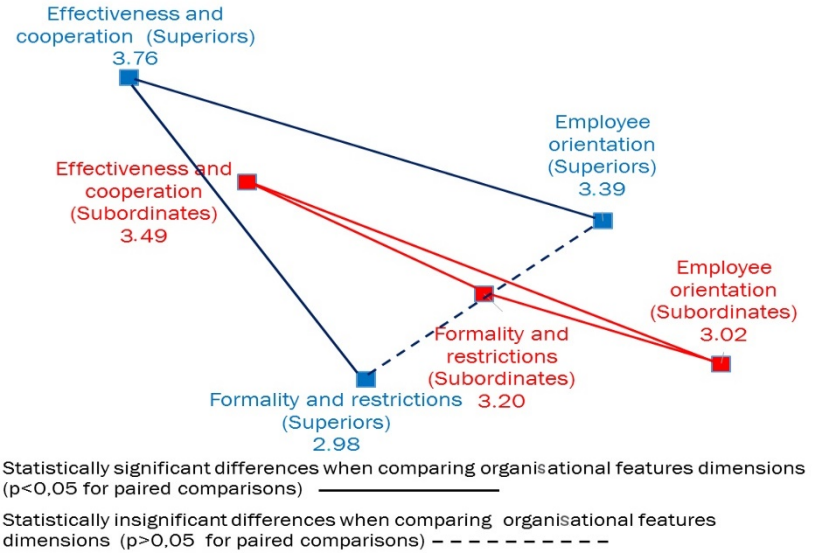

Fig. 3. Intra-institutional and subordination level comparisons of mean scores of different organisational feature dimensions: municipal organisations

communication, restrictions and authoritarian management were more prevalent in their organisations than schools (Mann-Whitney statistics 4.689, $p<0.001$).

In the first step of comparison of organisational features reciprocally at the intra-institutional level, several Mann-Whitney tests were performed to evaluate how employees or managers perceived the situation and evaluate organisational features and behaviour (Fig. 2 and 3).

Leaders of educational organisations perceive positive organisational features and typical behaviour in their organisation as more acceptable than employees (superiors gave higher scores to dimensions "Effectiveness and cooperation" and "Employee orientation", Mann-Whitney statistics -3.226 and -5.448,

respectively, and p<0.001; Fig. 2). Employees gave higher scores to the dimension "Formality and restrictions" (Mann-Whitney statistic 4.966, p<0.001) as superiors perceived or evaluated organisational features in their institutions as less authoritative, controllable and less focused on a short-term perspective.

Reciprocal values of every dimension of organisational features and occupational behaviour were compared in these groups of participants: a) superiors of school institutions, b) subordinates of school institutions (a, b: Fig. 2), c) superiors of municipality institutions, and d) subordinates of municipality institutions (c, d: Fig. 3).

Based on results of related sample comparisons, leaders of educational institutions claimed that organisational values and behaviour, such as effectiveness and cooperation, effective tasks and time management, openness to change and improvement and employee-oriented behaviour (fair and adequate rewards, meeting employee expectations, effective motivation system, healthy psychological climate) were appreciable and typical in their institutions (Friedman's test statistics 65.789, p<0.001; pairwise comparison for dimensions "Effectiveness and cooperation" and "Employee orientation" p=0.988; Fig. 2). Also, superiors supposed that formal relationships, control and authoritarian management were likely unrepresentative for their institutions (the mean score for the dimension "Formality and restrictions" was the lowest compared to scores of other dimensions; both pairwise comparisons p<0.001).

Employees of educational institutions stated that the highest scores were given to organisational features related to "Effectiveness and cooperation" behaviour (Friedman's test statistics 62.123, p<0.001; pairwise comparisons with dimensions "Formality and restrictions" and "Employee orientation" both were p<0.001; Fig. 2). However, "Employee orientation" behaviour was not incidental as superiors claimed, and the dimension score was no significantly different compared to the score for the dimension "Formality and restrictions" (p=0.621 for pairwise comparison).

Superiors or municipal organisations evaluated organisational features, values and organisational behaviour as more desirable and positive in their institutions than subordinates. Managers perceived higher effectiveness, collaboration and the tendency for positive change (p=0.002 for Mann-Whitney statistics; Fig. 3), stronger employee orientation and empowerment, more effective motivational actions (p=0.005) and lower restrictions, control and formal communication in occupational situations (p<0.001).

Superiors of municipal organisations perceived effectiveness and cooperation as the strongest organisational features of their institutions (Friedman's test statistic 51.493, p<0.001; pairwise comparisons with dimensions "Employee orientation" and "Formality and restrictions" p<0.001; Fig. 3). However, scores for dimensions "Employee orientation" and "Formality and restrictions" were not significantly different (p=0.280 for pairwise comparisons).

Results for subordinates of municipal institutions were different than results for professionals of educational organisations. Employees evaluated the effectiveness, cooperation, initiative, effective task and time management as the most prevalent organisational features and behaviour (Fig. 3). Regrettably, employee orientation, effective relationships at work, creative thinking and fair appreciation were evaluated as the least prevalent features and behaviour, and even formal communication, obedience to authority and restrictions were more prevalent compared to employee orientation and appreciation in these organisations (Friedman's test statistic 110.783, p<0.001; p<0.001 for every pairwise comparison).

Organisational values and features, such as effectiveness and cooperation, employee orientated behaviour and formal interaction and restrictions at work, did not correlate significantly with participants' age and length of work experience irrespective of institution's type and subordination level (Table 2: p>0.05 for all correlations coefficients except one — elder subordinates of municipal organisations gave a higher score to effectiveness and cooperation at work than younger colleagues, ρ=0.135, p=0.040).

The analysis of compared dimension scores by gender supported the notion that only subordinates tended to perceive and evaluate organisational values, features and behaviour differently depending on gender: female subordinates from educational institutions stated that effectiveness and cooperation (p=0.009 for Mann-Whitney test) and employee-oriented behaviour (p=0.025) were more prevalent, while formal communication, authoritarian management and restrictions were less prevalent (p=0.046) in their organisations (Fig. 4). There were no significant differences in evaluations of organisational values between male and female leaders of educational institutions (p>0.05 for every comparison; Fig. 4).

No significant associations were found between organisational features and superiors' gender in municipality institutions (p>0.05 for all Mann-Whit-

Tab. 2. Correlations between scores for organisational features dimensions, and age and the length of work experience of participants

Institutional and subordination level		Effectiveness and cooperation dimension	Employee orientation dimension	Formality and restrictions dimension
Educational organisations (superiors)	Age	ρ=-0.025 p=0.856)	ρ=0.084 p=0.534	ρ=-0.208 p=0.120
	Length of work experience	ρ=-0.111 p=0.413	ρ=-0.031 p=0.818	ρ=-0.056 p=0.681
Educational organisations (subordinates)	Age	ρ=-0.049 p=0.603	ρ=-0.134 p=0.153	ρ=0.025 p=0.794
	Length of work experience	ρ=0.054 p=0.571	ρ=-0.086 p=0.363	ρ=0.028 p=0.769
Municipal organisations (superiors)	Age	ρ=0.199 p=0.097	ρ=0.087 p=0.473	ρ=-0.152 p=0.205
	Length of work experience	ρ=0.217 p=0.069	ρ=0.062 p=0.605	ρ=-0.066 p=0.587
Municipal organisations (subordinates)	Age	ρ=0.135 p=0.040	ρ=0.019 p=0.779	ρ=0.031 p=0.636
	Length of work experience	ρ=0.031 p=0.640	ρ=-0.064 p=0.334	ρ=0.124 p=0.060

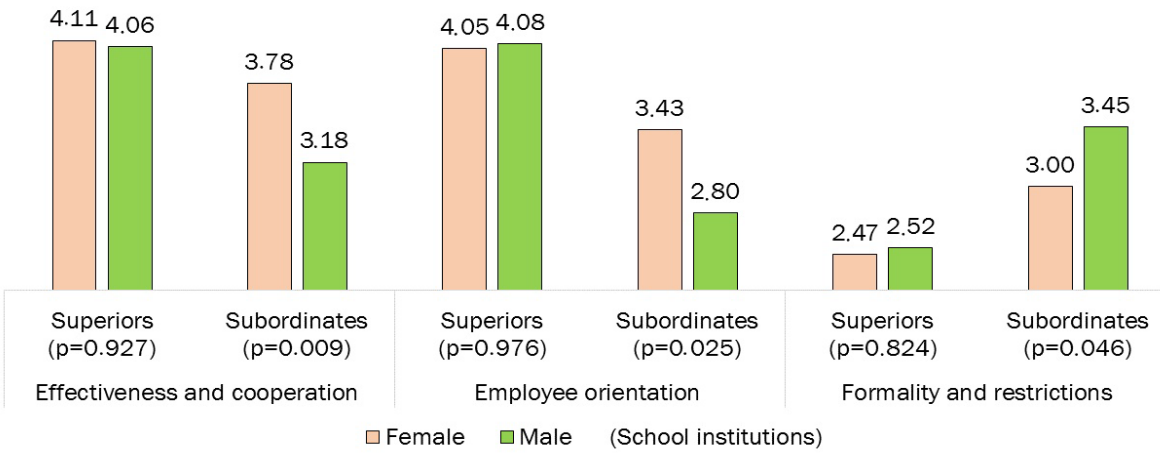

Fig. 4. Comparisons of mean scores for organisational feature dimensions considering gender and subordination level of participants: educational organisations

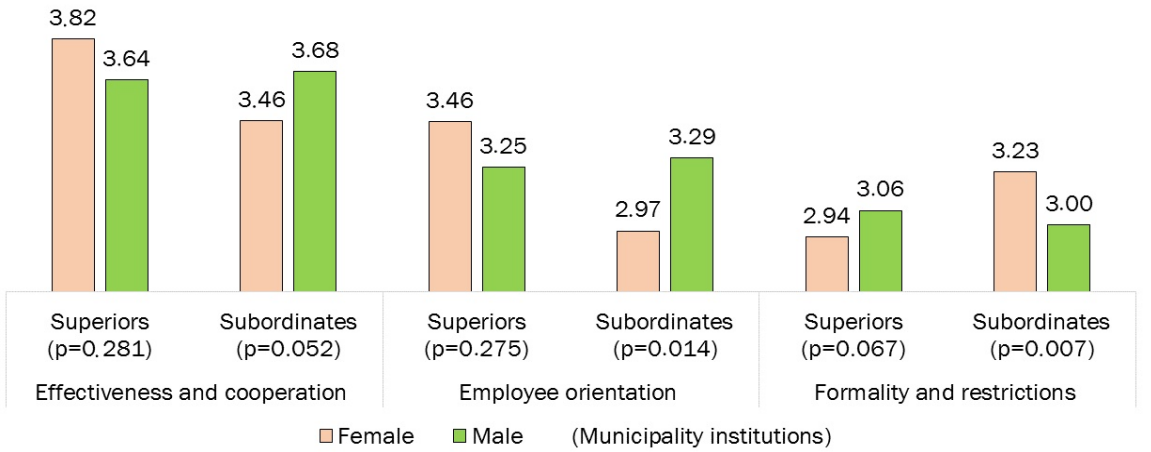

Fig. 5. Comparisons of means scores for organisational feature dimensions considering gender and subordination level of participants: municipal organisations

ney tests; Fig. 5; however, a tendency was observed that male managers perceived formality and restrictions as more important in their organisations compared to female managers). In the case of municipal organisations, subordinates had an opposite opinion than educational organisation employees. Male employees of municipal organisations reported higher effectiveness and cooperation ($p=0.052$ for Mann-Whitney test), higher employee orientation ($p=0.014$) and lower formality, authoritarian management and restrictions ($p=0.007$) than female colleagues.

Conclusions

The empirical research examined the values of educational and municipal organisations and how they were influenced by various factors, such as age, length of service, and the nature of work. Based on the results, three groups of organisational values were made reflecting different dimensions of organisational culture, namely, "Effectiveness and cooperation", "Employee orientation", and "Formality and restrictions". The dimensions and their expression reveal the value orientations of researched public organisations and how they differ. Analysis of the results showed that the organisational values of municipal and educational organisations significantly differed in all dimensions. Task effectiveness, time management and cooperation, employee-orientated behaviour were stronger in educational organisations compared to municipal organisations. Authoritarian management, formality and restrictions were stronger in municipal organisations than educational institutions. Such differences allow assuming that these organisations have different dominant values due to different organisational structure and societal challenges. Based on the theoretical reasoning by Nabatchi (2011), many political decisions in a public organisation are essentially a choice between competing but mutually necessary values, which he divided into a bureaucratic and democratic ethos, and a municipal organisation seems to be more likely bureaucratic.

Data analysis with respect to subordination level revealed somewhat significant differences in the perception of organisational values. Superiors claimed that positive organisational values, such as effectiveness, time management, cooperation, intentions to change, employee-orientated behaviour, encouragement and motivation, creativeness and autonomy, long-term organisational goals were more typical in both types of institutions. Formal communication, restrictions, control and obedience to authority were more typical for employees than managers. Comparing the value priorities of leaders and subordinates of both types of organisations, it can be stated that not all values that were important to leaders were also important to subordinates. Meanwhile, such values as formal communication, restrictions, control and obedience to authority were more visible to employees than managers.

The analysis of the perceptions of leaders and subordinates of both types of organisations revealed that educational institutions had more shared values between the two groups of employees, while in municipal organisations, the perceptions of leaders and subordinates about communication and cooperation and employee empowerment were radically different. Leaders of education institutions claimed that effectiveness and cooperation, and employee-oriented behaviour were very much appreciated and typical in their institutions, and formal relationships and restrictions were the least typical in educational organisations. The highest scores for organisational features were related to effectiveness and cooperation behaviour, and formal relationships, restrictions and employee-oriented behaviour were the least typical in school organisations according to subordinates.

Superiors of municipal organisations perceived effectiveness and cooperation as the strongest organisational features in their institutions, while formal relationships, restrictions and positive employee-oriented behaviour were less prevalent. Employees of municipal institutions evaluated effectiveness and cooperation as the most prevalent organisational features and behaviour. However, formal communication, obedience to authority and restrictions were more prevalent than positive employee orientation. Employee-orientated behaviour and empowerment were evaluated as the least typical by subordinates.

Elder subordinates of municipal organisations perceived effectiveness and cooperation as more important than younger colleagues. Effectiveness and cooperation, employee-orientated behaviour and formal interaction and restrictions at work were not associated with participants' age and the length of work experience irrespective of the type of institution type and the level of subordination.

Only subordinates tended to perceive and evaluate organisational values, features and behaviour differently depending on gender. Female subordinates from schools stated that effectiveness and cooperation, and employee-oriented behaviour were more

prevalent, and formal communication and restrictions were less prevalent in their organisations. Male employees of municipal organisations focused more on effectiveness and cooperation, employee orientation and lower formality, authoritarian management and restrictions.

Thus, it can be stated that different types of public organisations also have different organisational values. Although there is no one superior or ideal culture, organisations have to respond to challenges and highlight their core values so that they are understood and accepted by members of the organisation (Cameron & Quinn, 2011).

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Linking the employee voice to a more sustainable organisation: the case of Lithuania

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ABSTRACT
During the past years, sustainability has become an idea of organisational development. There is a growing trend to focus more not only on yield and economic profit but also on the care for the environment and contribution to the social balance, simultaneously delivering economic, social, and environmental benefits. This paper aims to determine how employee voice can lead to a more sustainable organisation by examining the gap between employee preferences and the current situation. The quantitative method in the form of a survey was used to examine the role of employee voice in the journey towards a more sustainable organisation across different sociodemographic characteristics. Four-hundred-and-twelve complete responses from Lithuanian employees representing different business and public sector organisations were used for analysis. The results of empirical research revealed a significant gap between the employee voice (importance of sustainable behaviour) regarding economic, social and environmental issues and the manifested corresponding sustainable behaviour. The largest interval in values of the employee voice and the current situation was determined in the groups of sustainable environmental behaviour and sustainable economic behaviour.

KEY WORDS
employee voice, sustainability, sustainable organisation, sustainable behaviour

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Introduction

There is a growing trend to focus more on sustainability, covering ecological, socio-cultural and economic pillars (Horlings, 2015; Ciarniene et al., 2018; Bombiak & Marciniuk-Kluska, 2019; Zawawi & Wahab, 2019; Čiarnienė et al., 2020; Crucke et al., 2021). Sustainability is a present-day idea of organisational development. Organisations are under pressure to find practices that help deal with biodiversity loss, growing social inequalities, and unsustainable use of

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limited resources (Rezapouraghdam, 2019). According to Bombiak and Marciniuk-Kluska (2019), Zawawi and Wahab (2019), Dzhengiz (2020), sustainable organisations that operate in the current challenging environment are capable of ongoing development, adaptation, learning, revitalisation and reorientation.

Employees with different demographic profiles, values, priorities, and expectations are at the heart of every organisation. Employee behaviour in organisations is one of the most critical factors translating sustainable principles into practice. Company leaders should listen to the employee voice, respect it and act upon it. Over the years, interest in employee voice has spread across several academic disciplinary areas. Employee voice means the ability of employees to have "a say" in the matter of work activities and decisions within the organisations with the intent to improve the situation at work (Wilkinson et al., 2018; Su et al., 2017). It can be explored from different perspectives, ranging from the communication behaviour on the macro-level (unionism and collective bargaining) to the micro-level, with the intent to influence decision making and improve organisational functioning (Morrison, 2014; Su et al., 2017; Dundon et al., 2004; Tsang & Zhang, 2018).

The growing interest in sustainability is expressed in many research outputs worldwide, examining various sustainability issues and contributing to understanding the outcomes of sustainable behaviour for individuals, organisations and humanity in general (Čiarnienė et al., 2020). Although concepts of sustainability, sustainable organisation and sustainable behaviour are dynamic research areas that the scientific community have widely analysed in recent years, a research gap remains in the field that links sustainable behaviour in an organisation and employee voice. The study aims to determine how employee voice can lead to a more sustainable organisation by examining the gap between employee preferences and the current situation. The first part of the paper presents a literature review on sustainable organisation and employee voice. Part two presents the study design and research instruments. The research results are discussed in the third part of the paper. The final part provides conclusions and directions for future research efforts.

1. Literature review

During the past years, sustainability has become one of the most important goals of the global policy agenda (Kaivo-oja et al., 2013; Van de Kerk, 2014; Horlings, 2015; Ciarniene et al., 2018; Bombiak & Marciniuk-Kluska, 2019; Zawawi & Wahab, 2019; Čiarnienė et al., 2020). The 2030 Agenda for Sustainable Development underlines a global commitment to balanced integration of economic, social and environmental dimensions (United Nations, 2015). Integration of these three dimensions is an urgent interest among the scientists, planners, policymakers and the public (Kaivo-oja et al., 2013; Van de Kerk, 2014; United Nations, 2015). People and societies in which they live, organisations where they work are shaped by and, in turn, shape economies that support their livelihoods and enhance their overall quality of life (United Nations, 2015).

Various scholars have studied the concept of a sustainable organisation (Zawawi & Wahab, 2019; Crucke et al., 2021; Bastas & Liyanage, 2019; Nawaz & Koç, 2019; Dzhengiz, 2020; Grecu et al., 2020; Župerkienė, Paulikas & Abele, 2019). According to Nawaz and Koç (2019, p.3), organisational sustainability is defined as an organisation's ability to make a positive contribution to "sustainable development by delivering simultaneously economic, social, and environmental benefits". Mitleton-Kelly (2011, p. 46) noted that "it is more than just enduring but an organisation where employees are actively involved in a continuous process of change; one in which the organisation's culture embraces different ways of working, relating, and thinking to remain viable". High sustainability organisations can outperform their competitors in economic, social and environmental measures (Wales, 2013; Crucke et al., 2021; Bastas & Liyanage 2019). According to different authors, organisational sustainability has been gaining acknowledgement and importance as it offers a competitive advantage and creates value for organisations, their stakeholders, and society in general. Moreover, all efforts of a sustainable organisation are focused on the contribution to ensuring sustainability.

Various studies emphasise that economic, social, and environmental activities of a sustainable organisation must be equivalent and complementary (Zawawi & Wahab, 2019; Čiarnienė et al., 2020; Nawaz & Koç, 2019; Kim et al., 2016; Rezapouraghdam et al., 2019; Batista & Francisco, 2018; De Medeiros et al., 2018; Bulut et al., 2017; Diprose et al., 2019; Ahmed et al., 2019; Coughlin, 2018, and others). Economic, environmental and social goals are interrelated and mutually reinforcing; furthermore, they need to be considered in a balanced manner (Bom-

biak & Marciniuk-Kluska, 2019; Batista & Francisco, 2018; Rezapouraghdam et al., 2019; De Medeiros et al., 2018; Ciarniene et al., 2018). Those organisations that strive to not only yield an economic profit but also care for the environment and contribute to the social balance substantiate their activities on the triple-bottom-line principle and are referred to as sustainable organisations.

Based on Rimanoczy and Pearson (2010), Bombiak and Marciniuk-Kluska (2019), Koç and Bastas (2019), Wales (2013), Čiarnienė et al. (2020), Ahmed et al. (2019), De Medeiros et al. (2018), Bulut et al. (2017), Diprose et al. (2019), Coughlin (2018), Bastas and Liyanage (2019), Crucke et al., (2021), Dzhengiz (2020), Grecu et al. (2020), organisational sustainability categories and best practices in each of the three facets of sustainable development can be identified.

1. Economic sustainability includes sustainable financial welfare creation, economic performance, efficient use of resources minimising wastage, cost savings and other economic issues.
2. Environmental sustainability involves reduction of environmental degradation, protection of natural resources, recycling, energy-saving, pollution control, and skilful waste management.
3. Social sustainability is considered a commitment to respond to the needs of all stakeholders of an organisation, such as internal and external human resources, etc. It covers education, human rights, health protection and safety, pro-ecological learning, employee well-being and satisfaction, regional development, and other social issues.

The concept of employee voice has received substantial research attention since the 1980s, primarily in the fields of human resource management, employment relations and organisational behaviour (Wilkinson et al., 2018; Barry & Wilkinson, 2016; Jha et al., 2019). Over the years, the interest in employee voice has spread across several academic disciplinary areas. Across disciplinary boundaries, views about what employee voice is and how it could be examined strongly differed (Barry et al., 2018). The absence of employee voice, i.e., employee silence, means that an employee chooses to withhold his/her voice (Hickland et al., 2020). It may be a sign that the organisation lacks morale and the opportunity to improve is at risk (Donovan et al., 2016; Morrison, 2014). The employee perception of getting the opportunity to voice concerns and be heard determines their engagement in the organisation (Jha et al., 2019). According to Dundon et al. (2004), employee voice can occur in various forms and can be understood as a complex and uneven set of meanings and purposes:

- an expression of individual dissatisfaction or concern about a specific problem or issue;
- a form of collective organisation, where the voice provides a compensatory source of power for management;
- a contribution to decision-making;
- an instrument for mutual benefit, increasing the prosperity of an organisation and the well-being of employees.

Other authors emphasise three dimensions of employee voice: 1) individual voice versus collective voice, 2) employee-employer shared agenda versus contested agenda, and 3) the extent of employer influence versus employee influence over decision making (Wilkinson et al., 2014; Tsang & Zhang, 2018). Su et al. (2017) classify motives for employee voice into two groups: prosocial motives and constructive motives. Prosocial motives refer to the desire to build positive relationships with others, while constructive motives show commitment to the organisation and lead to improving the performance and prosperity of the organisation.

According to the authors, employee voice can also have two dimensions: promotive and prohibitive. Promotive voice refers to ideas and suggestions for improvement, while prohibitive voice draws the organisations' attention to the concerns and harmful factors (Su et al., 2017).

Wilkinson, Dundon, and Marchington (2013) presented a framework to examine employee voice system through the following elements:

- the degree or extent to which employees can influence decision making;
- the level at which voice is expressed (task, departmental, corporate);
- the range of issues from the trivial to operational and to more strategic concerns;
- the form that voice takes.

Morrison (2014) noted the effect of individual difference in demographics, attitudes, personality, and work-related factors on employee voice (Tsang & Zhang, 2018). On the other hand, organisational variables, such as structure, culture and leadership style, moderate the relationship between the motive to benefit the organisation and employee voice (Tsang & Zhang, 2018). Su et al. (2017), Grecu et al. (2020) emphasised employee voice as an important information source for managerial decision-making and the potential to contribute to organisational sustainability.

Becoming a more sustainable organisation is driven by different factors, but active employee voice in organisations is one of the most important when implementing ideas of sustainability into practice. Therefore, it is crucial to examine the role of employee voice in the effort to create a more sustainable organisation across different sociodemographic characteristics.

2. Research methods

For the purposes of the study, a questionnaire was developed with items related to sociodemographic characteristics of respondents (year of birth, gender, education, organisation's type, professional position and experience) and items that evaluated the manifestation (in the current situation) of the sustainable behaviour in the organisation and employee voice regarding sustainability (the importance of sustainability). The questionnaire was developed based on analysis and synthesis of scientific literature.

The manifestation and importance of sustainability in respondent organisations were assessed using a 20-item questionnaire. Each item was measured on a 5-point Likert scale (1=strongly disagree, 5=strongly agree). A higher score represented a higher level of manifested sustainability and importance according to employee voice.

The sustainable economic behaviour domain was evaluated using a 7-item scale to measure the aim for greater efficiency and productivity; motivating employees based on the results achieved; costs saving, clear tasks, deadlines and resources; efficient use of time (De Medeiros et al., 2018; Čiarnienė et al., 2020; Bulut et al., 2017; Bombiak & Marciniuk-Kluska, 2019; Wales, 2013; Kaivo-oja et al., 2014; Grecu et al., 2020; Bastas & Liyanage, 2019; Vlacsekova & Mura, 2017).

The sustainable social behaviour domain used a 6-item scale to assess the encouragement of creative thinking and initiative; care for employee safety, health and leisure, good relations between employees, and information sharing (De Medeiros et al., 2018; Čiarnienė et al., 2020; Diprose et al., 2019; Coughlin, 2018; Bombiak & Marciniuk-Kluska, 2019; Koç & Bastas, 2019; Wales, 2013; Kaivo-oja et al., 2014; Grecu et al., 2020; Dzhengiz, 2020; Crucke et al., 2021).

The sustainable environmental behaviour domain measured the use of public transport; waste sorting and recycling; alternative renewable energy sources; environmental education; sustainable use of natural and energy resources; and sustainable activities (Čiarnienė et al., 2020; Bulut et al., 2017; Diprose et al., 2019; Bombiak & Marciniuk-Kluska, 2019; Wales, 2013; Ahmed et al., 2019; De Medeiros et al., 2018; Kaivo-oja et al., 2014; Grecu et al., 2020; Bastas & Liyanage, 2019).

Once the initial pool of questionnaire items was created, the statements were reviewed by five qualified social science experts specialising in sustainable management and economics. The revision of the statements led to some corrections ensuring their accuracy, absence of item construction problems and grammatical errors.

Cronbach's alpha test was used for the reliability of the questionnaire (Table 1). Values of the Cronbach's alpha coefficient fluctuate from 0.86 to 0.90, which significantly exceeds minimal recommended values.

All statistical analyses were conducted with SPSS 22 (descriptives, one-way Anova (F), Wilcoxon matched-pair sign test, paired-samples and independent-samples t tests, Spearman's (ρ) correlation). The research was carried out in 2019 in the Republic of Lithuania. The sample size was determined using a calculator (https://www.surveysystem.com/sscalc.htm#one). Based on the estimated sample (384), 430 questionnaires were distributed using convenience sampling. Data collection was conducted both online and by distributing printed questionnaires to respondents. 412 questionnaires were filled out completely and used for analysis.

Tab. 1. Cronbach's alpha values by sustainability domains (N=412)

Sustainability domains	Number of items	Cronbach's alpha	
		Manifestation of sustainability	Importance of sustainability
Sustainable economic behaviour	7	0.87	0.90
Sustainable social behaviour	6	0.89	0.88
Sustainable environmental behaviour	7	0.86	0.90

Tab. 2. Sociodemographic characteristics of respondents

Characteristics		N (%)
Education	University	332 (80.6%)
	College	44 (10.7%)
	Secondary school	36 (8.7%)
Gender	Female	232 (56.3%)
	Male	180 (43.7%)
Respondent's organisation	Business sector	184 (44.7%)
	Public sector	228 (55.3%)
Generation (respondent's year of birth)	1944–1964	128 (31.1%)
	1965–1981	124 (30.1%)
	1982–2002	160 (38.8%)
Position	Leader	72 (17.5%)
	Specialist/office worker	248 (60.2%)
	Other	92 (22.3%)
Professional experience	Less than 12 months	28 (6.8%)
	1–5 years	56 (13.6%)
	6–10 years	52 (12.6%)
	11–20 years	96 (23.3%)
	More than 20 years	180 (43.7%)

Table 2 provides detailed information on respondent characteristics (gender, education, generation and professional area).

3. Research results

The results on the manifestation of economic, social and environmental sustainability in business and public sector organisations are presented in Fig. 1. Economic and social manifestations of sustainability were more frequent in business organisations than public sector institutions (for economic sustainability $t=2.627$, $p=0.009$, mean scores 3.80 ± 0.75 and 3.61 ± 0.73, for social sustainability $t=4.804$, $p<0.001$, mean scores 3.67 ± 0.81 and 3.26 ± 0.90). The manifestation of environmental sustainability was similarly reported by employees of public and business sector institutions ($t=1.206$, $p=0.228$, mean scores 2.95 ± 0.70 and 2.85 ± 0.93).

The importance of sustainable behaviour related to economic (statistics for paired samples $t=-19.879$, $p<0.001$; Fig. 2), social ($t=-21.224$, $p<0.001$) and environmental issues ($t=-25.105$, $p<0.001$) was more significant for employees than the manifestation of the corresponding sustainable behaviour.

Further analysis of the statements and aspects that are related to economic, social and environmental issues endorsed the results: employees stated that every aspect (statement) of a particular sustainable behaviour was more important to them than its manifestation in the organisation (mean scores for every statement are presented in Fig. 3, Wilcoxon statistic $p<0.001$ is for every pair of statements).

The largest gap between the manifestation and employee voice (desired situation) was found in groups of sustainable environmental behaviour and sustainable economic behaviour. In the group of sustainable environmental behaviour, respondents emphasised inadequate use of alternative renewable energy sources (values between 2.6 and 4.0), inadequate environmental education (2.8 and 4.1), and insufficient encouragement to use public transport (2.3 and 3.5). In the group of sustainable economic

behaviour, the largest gap was determined in the areas of employee motivation (3.3 and 4.5) and the use of work time (3.4 and 4.5). In the group of sustainable social behaviour, employee expectations were least met in areas of good friendly relations (3.5 and 4.5) and open information sharing (3.4 and 4.4).

The importance of sustainable behaviour for respondents by sociodemographic characteristics is presented in Table 3.

Female respondents gave higher scores in every domain to the importance of sustainable behaviour compared to male respondents ($p<0.05$ for Student t statistics). There was no statistical significance determined between the level of education and the importance of economic and sustainable environmental behaviour ($p>0.05$ for Anova statistics). Respondents with college education perceived sustainable social behaviour as least important in their organisation compared to respondents with secondary school or university education. There was moderate statistical significance between the duration of professional experience and the importance of sustainable behaviour, i.e., the lengthier was the professional experience of a respondent, the more important was economic ($\rho=0.154$, $p=0.002$), social ($\rho=0.160$, $p=0.001$) and sustainable environmental behaviour ($\rho=0.169$, $p=0.001$).

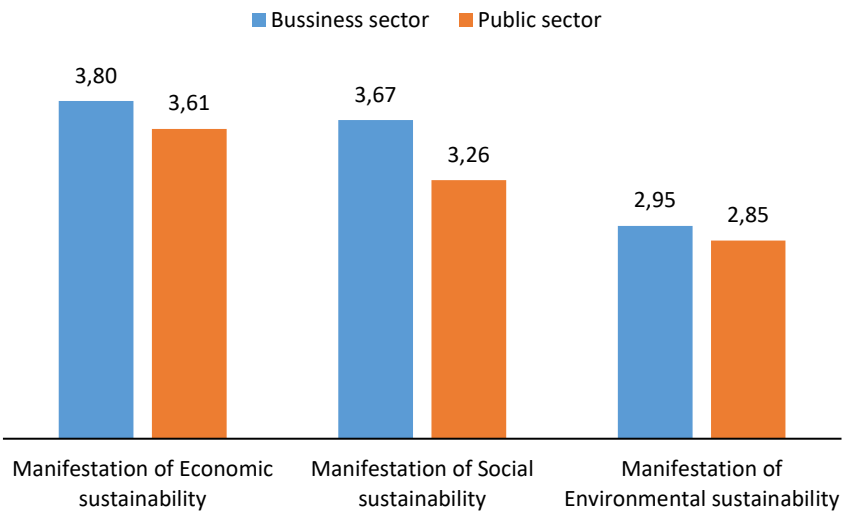

Fig. 1. Mean scores for manifestations of economic, social and environmental sustainability in business and public sector organisations

Fig. 2. Comparison of mean scores for the manifestation and importance of economic, social and environmental sustainability domains

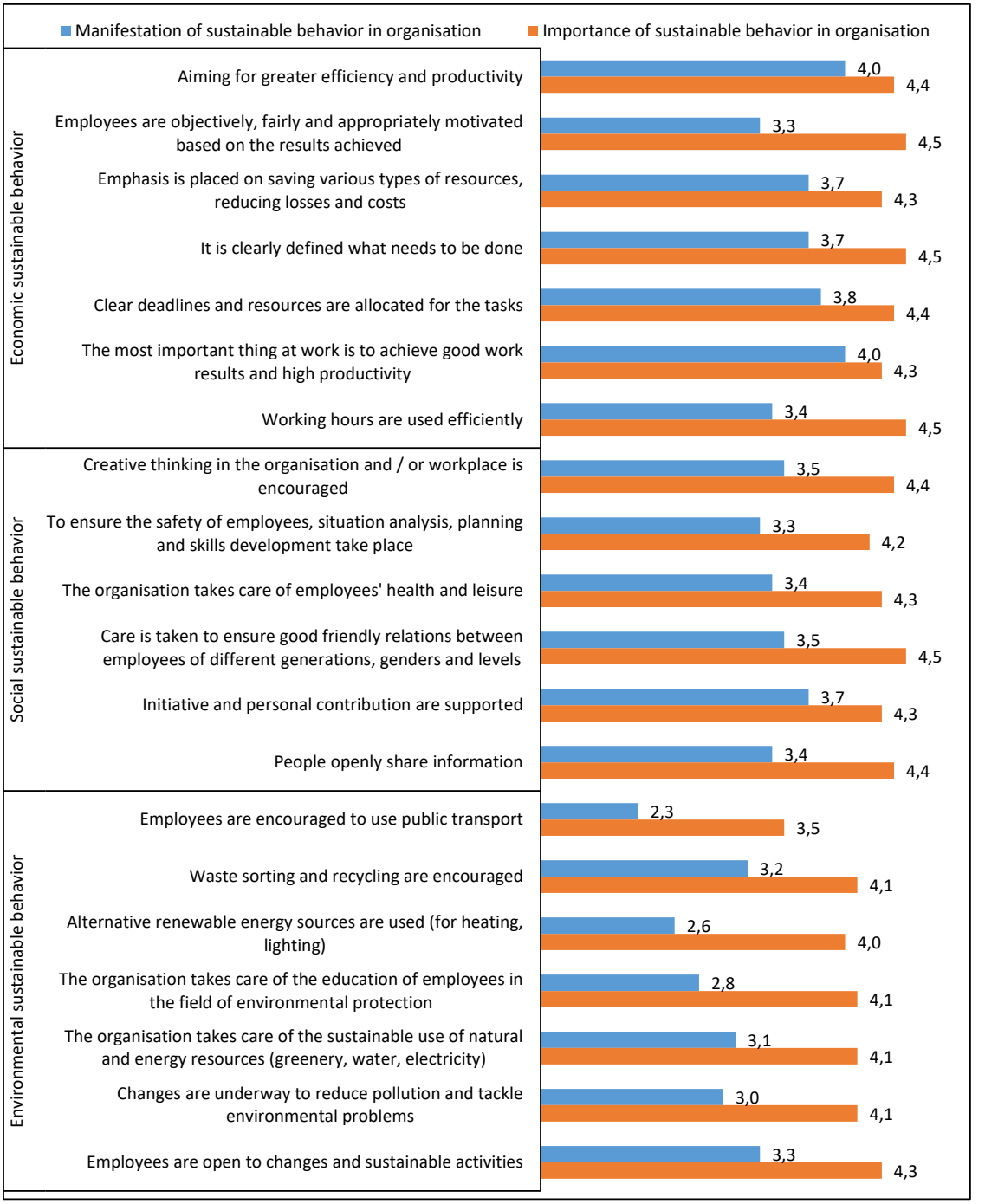

Fig. 3. Comparison of mean scores for every pair of statements for the manifestation and importance of economic, social and environmental sustainability domains

The results revealed that the youngest respondents (the generation of 1982–2002) gave the lowest scores to the importance of every domain of sustainable behaviour. There were no statistically significant relationships between the work positions of the respondents and the importance of sustainable economic and social behaviour. However, leaders claimed that sustainable environmental behaviour was the least important for them than specialists and office workers.

Tab. 3. Importance of sustainable economic, social and environmental behaviour and its relationship to sociodemographic characteristics

Sociodemographic characteristics		Mean±st.dev.	Statistics	Pairwise comparisons (Anova statistics)
Sustainable economic behaviour				
Education	University College Secondary school	4.41±0.62[a] 4.39±0.63[b] 4.38±0.48[c]	F(2.409)=0.067. p=0.935	p>0.05 [a-b] p>0.05 [a-c] p>0.05 [b-c]
Gender	Female Male	4.47±0.47 4.33±0.74	t=2.177. p=0.030	–
Generation (respondent's year of birth)	1944–1964 1965–1981 1982–2002	4.46±0.48[a] 4.50±0.75[b] 4.30±0.55[c]	F(2.409)=4.608. p=0.010	p>0.05 [a-b] p>0.05 [a-c] p=0.016[b-c]
Position	Leader Specialist/office worker Other	4.56±0.92[a] 4.37±0.51[b] 4.37±0.52[c]	F(2.409)=2.904. p=0.056	p>0.05 [a-b] p>0.05 [a-c] p>0.05 [b-c]
Sustainable social behaviour				
Education	University College Secondary school	4.38±0.60[a] 4.12±0.54[b] 4.43±0.52[c]	F(2.409)=4.039. p=0.018	p=0.019[a-b] p>0.05[a-c] p=0.033[b-c]
Gender	Female Male	4.45±0.48 4.23±0.70	t=3.621. p<0.001	–
Generation (respondent's year of birth)	1944–1964 1965–1981 1982–2002	4.49±0.49[a] 4.33±0.73[b] 4.28±0.54[c]	F(2.409)=4.940. p=0.008	p>0.05[a-b] p=0.07[a-c] p>0.05[b-c]
Position	Leader Specialist/office worker Other	4.43±0.89[a] 4.34±0.53[b] 4.33±0.46[c]	F(2.409)=0.752. p=0.479	p>0.05 [a-b] p>0.05 [a-c] p>0.05 [b-c]
Sustainable environmental behaviour				
Education	University College Secondary school	3.99±0.73[a] 3.92±0.69[b] 4.29±0.42[c]	F(2.409)=3.034 p=0.049	p>0.05 [a-b] p>0.05 [a-c] p>0.05 [b-c]
Gender	Female Male	4.13±0.68 3.86±0.77	t=3.803. p<0.001	–
Generation (respondent's year of birth)	1944–1964 1965–1981 1982–2002	4.18±0.55[a] 4.04±0.78[b] 3.85±0.78[c]	F(2.409)=7.796 p<0.001	p>0.05[a-b] p<0.001[a-c] p>0.05[b-c]
Position	Leader Specialist/office worker Other	3.85±0.71[a] 4.09±0.64[b] 3.91±0.92[c]	F(2.409)=4.207 p=0.016	p=0.027[a-b] p>0.05 [a-c] p>0.05 [b-c]

Conclusions

Recently, there has been an increasing interest in sustainability as a present-day idea of organisational development. Although the topic of a sustainable organisation is widely analysed by the scientific community, there is a lack of intersection between a sustainable organisation and employee voice. The primary objective of this study was to investigate how employee voice can lead to a more sustainable organisation examining the gap between employee preferences and the current situation.

As a theoretical and empirical contribution, this study showed that employees with different demographic profiles, priorities, and expectations could lead to a more sustainable organisation through economic, environmental and social domains. Employee voice in organisations is one of the most important factors translating sustainable principles into practice.

Sustainability as "a prescriptive notion recommends how humans should behave with respect to the environment and highlights their responsibility towards each other and future generations" (Grecu et al., 2020, p.3). During the past years, organisations have been facing an increased pressure to focus on new, sustainable practices to make a positive contribution to economic, social, and environmental balance (Kaivo-oja et al., 2013; Van de Kerk, 2014; Horlings, 2015; Rezapouraghdam et al., 2019; Bombiak & Marciniuk-Kluska, 2019; Zawawi & Wahab, 2019; Čiarnienė et al., 2020; Grecu et al., 2020; Crucke et al., 2021, and others). Organisations are integrating

economic, social and environmental considerations into their management processes, driven by an increased concern among scientists, planners, policymakers and other stakeholders and the public (Kaivooja et al., 2013; Van de Kerk, 2014; United Nations, 2015; Bastas & Liyanage, 2019).

Employee voice as an expression of individual satisfaction or dissatisfaction and concern, a source of power for management, a contribution to decision-making, and an instrument for mutual benefit is crucial in an attempt to develop a more sustainable organisation (Hickland et al., 2020; Crucke et al., 2021; Tsang & Zhang, 2018; Su et al., 2017; Akhmad, Suryadi & Rajiani, 2020).

The results of empirical research revealed a significant gap between the employee voice (importance of sustainable behaviour) regarding economic, social and environmental issues and the manifestation of the corresponding sustainable behaviour. The largest interval in values of employee voice (desired situation) and the manifestation was found in groups of sustainable environmental behaviour and sustainable economic behaviour. In the environmental domain, respondents emphasised the inadequate use of alternative renewable energy sources, inadequate environmental education, and insufficient encouragement to use public transport. In the economic domain, the largest gap was identified in the areas of employee motivation and the use of work time. In the social domain, employee expectations were least met in the areas of good friendly relations and open information sharing.

Based on the evaluation of sociodemographic characteristics of respondents, the voice of female respondents received higher scores in every domain for the importance of sustainable behaviour when compared to male respondents. This confirms the results of research conducted by Khan and Trivedi (2015) and Bulut et al. (2017) regarding gender differences in sustainable behaviour. Based on research by Bulut et al. (2017), De Medeiros et al. (2018), Coughlin (2018), Diprose et al. (2019), sustainable behaviour differs depending on the generation. This research partially confirmed their findings and revealed that sustainable behaviour related to social, economic and environmental aspects were the least important for the youngest respondents. Moderate statistical significance was found between respondents' professional experience and the importance of sustainable behaviour: the longer was the professional experience of respondents, the more important was sustainable economic, social and environmental behaviour.

Hamid et al. (2014) identified a significant relationship between sustainable behaviour and education. The findings of this study showed no statistical significance identified between the education of respondents and the importance of sustainable economic and environmental behaviour and between the work position of respondents and the importance of sustainable economic and social behaviour. However, the leaders claimed that sustainable environmental behaviour was the least important for them compared to specialists and office workers.

The authors agree with the findings of Su et al. (2017), Jha et al. (2019) and claim that by listening and responding to employee voice, organisations can benefit and contribute towards their sustainability. The attention of leaders to organisational sustainability should address the gap between employee preferences and the manifestation of sustainability (Tsang & Zhang, 2018; Crucke et al., 2021; Grecu et al., 2020).

This research opens a space for discussion and future scientific research efforts in the area of sustainability. The findings of this study can be useful for organisation leaders, practitioners, and policymakers, as behaviour leading towards a sustainable organisation helps to meet the needs of employees, the organisation and society as a whole. The limitation of this paper is the convenience sampling for the research and data gathering, which was not optimal. Concerning further research, it would be worthwhile to examine the role of employee voice in the journey towards sustainability across different countries and cultures.

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Customer experience analysis of cosmetics retail store on millennial women

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ABSTRACT

Nowadays, customer experience is one of the most powerful forces to increase customer satisfaction, customer loyalty, service quality, and company profit, especially for the cosmetics retail industry that is strongly influenced by the hedonic aspects. Therefore, this exploratory study aims to analyse plausible combinations of factors to reveal commonalities of online and offline customer experience with retail stores to support retailers in the alignment of the store system design with the promising profile of millennial women. The study uses a combination of several methods to conduct a comprehensive analysis, namely Eye Tracking (ET), Customer Journey Analysis (CJA), Retrospective Think Aloud (RTA), and In-Depth Interview (IDI). The analytical methods deliver qualitative and quantitative data to explore both positive and negative experiences from the customer point of view. The study reveals many possible factors that can bring positive or negative customer experience from a cosmetics retail store. Based on the findings, the design recommendations for offline and online cosmetics retail stores (physical, interface, and service systems) were made to help cosmetics retailers produce a positive customer experience. This paper provides two research contributions to the field of service experience. First, the study uses an original combination of four methods that have never been used to explore the experience comprehensively. The combination can increase the depth of this exploratory study in understanding the complexity of all customer experience dimensions. Therefore, this study brings a fresh perspective on the development of the method that can be used by many researchers in a similar area. Second, this study fills the existing gap in that area of exploratory research on customer experience in the cosmetics retail sector. This study could help many cosmetics offline or online retailers to improve their store system to bring a positive customer experience to millennial women as their biggest customer segment. This study could also inform the system design for new "players" in the cosmetics retail industry with valuable guidelines for a positive shopping experience at their store.

KEY WORDS

customer experience, cosmetics, millennial women, retail, eye tracking, customer journey analysis, retrospective think aloud, in-depth interview

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Introduction

Under tight competition, which is particular to many business sectors, customer experience is one of the main differentiators to attract customers and excel from the competitors (Bustamante & Rubio, 2017). The customer experience (CX) plays an essential role in influencing customers while interacting with products or services offered because the impact of CX can affect almost all aspects of human life. Customer experience strongly correlates with customer satisfac-

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tion, customer loyalty, service quality, purchase intention, and sales of the company (Koetz, 2019). This has made many companies in various sectors concerned about bringing a positive experience for their customers.

Customer experience is mostly formed in the retail industry, where there is an intensive interaction between the end-customers and the products or services. The retail industry with a B2C business model has the most interaction with the end customers to transact product or service. As the retailer always has intense interaction with their customers, understanding customer experience and behaviour should be crucial for them (Puccinelli et al., 2009). To correctly identify and deliver a positive customer experience, it is important to understand all human factors related to their shopping behaviour (Reason et al., 2016). For instance, shopping motivation must be understood (Arnold & Reynold, 2003) as well as goals or desires when buying (Ratneshwar et al., 2000), etc. This understanding makes it easier to design retail aimed at a positive experience.

Nowadays, the retail industry has two common types of business model, i.e., an offline store and an online store (e-commerce). These types of retail stores could have the same business goals yet different routes to the market. Different ways to interact with customers exist for both types of stores, so customers should be treated using different patterns. Thus, customer behaviour should be understood, and customer experience developed differently for each store type. Based on the timeframe, customer experience in all retail environments has three phases, i.e., prepurchase, purchase, and post-purchase (Lemon & Verhoef, 2016). Despite similar customer experience phases, activities and interactions that occur during each phase may differ. Therefore, this research aims to compare how to enhance positive customer experience between offline and online retail stores to gain more knowledge on better treatment of customers.

As a powerful driving force in the retail industry, customer experience could be a great differentiator in many sectors that are affected by hedonic aspects, such as buying experience, emotion, or pleasurability (Bascur & Rusu, 2020). Customer experience is one of the main differentiating strategies in the cosmetics industry to increase economic value (Nagasawa & Kizu, 2015). The cosmetics industry is an industrial sector that is significantly affected by some hedonic aspects like brand loyalty (Nezakati et al., 2013), pleasure, emotion (Apaolaza-Ibáñez et al., 2011), satisfaction (Upamannyu & Bhakar, 2014; Alkhamis, 2018; Kuntonbutr & Sangperm, 2019), and many more. Cosmetics customers usually buy their cosmetic products from offline or online retail stores. Positive customer experience plays an important role in choosing the wanted retail store. Some research is available about customer experience in retail environments or hedonic aspects in cosmetic products, but no research explores how to enhance the positive customer experience in a cosmetics retail store. Therefore, this research explores this gap to help cosmetics retailers to develop the right differentiator for their stores. It focused on the cosmetics sectors instead of making a more general exploration as every sector has typical customer behaviours and characteristics.

Since customer experience is highly affected by typical human behaviours, the research focused on millennial women or generation Y (Gen Y) who were born between 1981 and 1999 (Lancester & Stillman, 2002). This generation was selected for research because of four main reasons related to their characteristics. First, the millennial generation is the largest consumer population in the world (Moreno et al., 2017). Second, even though men are getting interested in using cosmetic products, women remain the main consumer group (Ramshida & Manikandan, 2014). Third, the majority of millennial women are still in their productive age (Smith & Nichols, 2015), so they tend to choose, buy, purchase, and consume cosmetic products. Fourth, since the research aims to compare the experience between offline and online stores, most of them have good adaptability to the technology required for online stores (digital natives). Consequently, the research targeted millennial women.

This research explores factors related to customer experience dimensions that can enhance the positive customer experience for millennial women in cosmetics retail stores. This research also explains the difference in relevant CX factors between offline, aiming to contribute to knowledge about how to build cosmetics retail stores that would bring positive customer experience.

1. Literature review

Customer Experience (CX) is a multidimensional construct of what customers think and feel about products, systems, or services related to business (Bascur & Rusu, 2020). The construct consists of cognitive, emotional, behavioural, sensorial, and social dimensions (Lemon & Verhoef, 2016). Positive customer experience is proven to increase customer satis-

faction (Lemon & Verhoef, 2016; Suzuki, Gemba & Aoyama, 2019; Almohaimmeed, 2020) and customer loyalty (Kim & Choi, 2013). For business owners, a positive customer experience can also be a powerful driving force to improve sales (Bustamante & Rubio, 2017), profit (Donoghue, 2002), service quality (Salehi et al., 2013), and purchase intention (Nasermoadeli et al., 2013). Considering the importance of customer experience, possible ways should be explored to enhance the positive customer experience as a powerful competitive differentiator for a business, product, or service. Customer experience is a complex construct that requires comprehensive analysis. Therefore, several methods were combined to explore all dimensions of CX. The analysis methods used in this research and their relationship with customer experience dimensions are given in Fig. 1.

Eye-Tracking (ET) is a powerful methodology to record and measure human eye movements to understand visual attention in real-time (Schall & Bergstrom, 2014). Eye-Tracking has been used for many fields of research, such as human cognitive factors (Schall & Bergstrom, 2014), human experience (Elbabour et al., 2017), consumer behaviour (Rosa, 2015), product or service usability (Pernice & Nielsen, 2009), neuromarketing (Santos et al., 2015), sensory experience (Cowen-Elstner, 2017), emotion recognition (Schurgin et al., 2014) and detection (Alshehri & Alghowinem, 2013), and many more. Eye-Tracking can measure three main visual attributes of human eyes, i.e., location, duration, and movement, permitting to examine natural human behaviour based on their visual attributes. Eye-Tracking can provide many insights into what makes a customer interested, how the customer pays attention to something, and what phenomenon-causing experience can occur at stores. This research used an Eye-Tracking method for natural and objective exploration of cognitive, emotional, behavioural, and sensorial dimensions of customer experience. Besides, some Eye-Tracking findings were used as basic insights to use the RTA method. Since participants should move actively in retail stores when their eye movements are captured, a wearable eye tracker (Tobii Pro Glasses 2) was used in this research. This eye tracker is an Eye-Tracking tool in the form of glasses, which allows participants to move freely when wearing it. The eye-tracking method provides a lot of data that can be analysed both qualitatively and quantitatively. Some of the qualitative data from eye-tracking were gaze replay, gaze plot, and heat maps, whereas some of the quantitative data from eye-tracking were time spent, number or duration of fixation, number or duration of visit, time to first fixation, pupil dilation, and many more.

Think Aloud (TA) is a method in the form of protocols used by a researcher to help participants to verbalise their thoughts working on a given task (Van Den Haak et al., 2003). This is a powerful protocol that allows understanding what participants think or feel at the time when an event occurs. There are two types of TA procedures, i.e., Concurrent Think Aloud (CTA) and Retrospective Think Aloud (RTA). CTA is a type of TA where participants verbalise thoughts during a task, whereas RTA is a type of TA where participants verbalise thoughts right after the tasks. Although there is no significant difference between CTA and RTA results (Van den Haak et al., 2003), participants tend to have better performance and more thoughts using RTA (Van den Haak et al., 2004). Therefore, this research used RTA to capture customer thoughts associated with their experience. RTA was used to explore customer experience based on the gaze replay from each participant.

The customer experience construct consists of natural customer responses and reactions to environmental stimuli along the customer journey (Becker

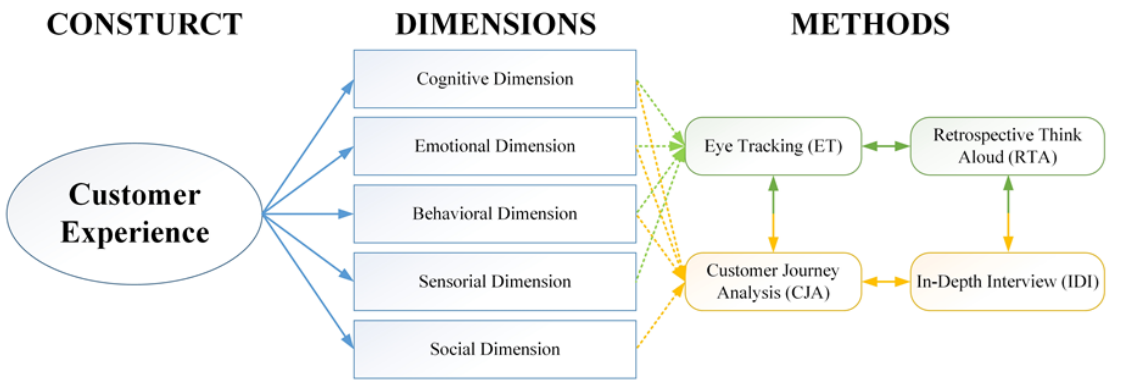


Fig. 1. Analysis methods and their relationship with CX dimensions

& Jaakkola, 2020). This research also used Customer Journey Analysis (CJA) to capture the experience of the customer in detail for every journey. CJA has been used for some service research, such as customer experience (Addis, 2016; Alawad et al., 2018), service quality (Halvorsrud et al., 2016), service design (Alves et al., 2012), etc. In the context of retail customer experience, the process of customer journey flows iteratively from the prepurchase phase to the purchase phase to the post-purchase phase (Lemon & Verhoef, 2016). During each phase, customers could interact with one or many touchpoints (i.e., anything that interacts with the customer) to achieve their goals for every step at retail stores. CJA aims to systematically explore the experience in every step and touchpoints of the customer journey. The customer journey map was used as a CJA tool for mapping the customer journey for all processes (Følstad & Kvale, 2018). There is some information for every process from the customer journey map, such as customer goals, customer expectations, process names, touchpoints, thinks and feels, and customer experience. This research used CJA for the exploration of cognitive, emotional, behavioural, and social dimensions of customer experience.

In-Depth Interview (IDI) is an intensive interview to explore participant's perspectives on particular subjects (Brounéus, 2014). In qualitative research, IDI is an effective tool to gather ideas, thoughts, or perceptions (Bolderston, 2012). IDI allows to explore and reflect on the experience of the participants qualitatively (Kormelink, 2020). This research used IDI for an in-depth qualitative analysis of a customer experience for every customer journey.

2. Research methods

This research was conducted to elucidate the real customer experience from cosmetics retail stores. To achieve these goals, extensive research involved three offline cosmetics retail stores and three online cosmetics retail stores in Indonesia, which specifically offer a selection of cosmetic brands (i.e., are not affiliated with certain brands) and target millennial women as their primary market. All selected stores had been operating for more than three years and widely known to eliminate a "new store" effect. The offline stores were "self-service", allowing customers to shop for any items wanted. This type of offline cosmetics retail stores is predominant in Indonesia. The chosen online stores only sold cosmetic products from a selection of brands. The stores had to have a unique name, location, and ownership to ensure their independence. Qualitative and quantitative data were taken from customer samples to explore the right experience from the customer perspective. Based on Fig. 1, this research used a systematic combination of methods to analyse all dimensions of customer experience based on the point of view of an actual customer.

All research participants were millennial women (aged 19 – 38) who had the intention to shop for cosmetic products and already had a shopping list. The research expected all participants to engage in natural shopping behaviour in a retail store, without any control over participant actions during their shopping experience. Thus, research participants were recruited in front of each offline store right before they entered it. For online stores, an announcement was disseminated on social media platforms to find participants who wanted to buy cosmetic products from the selected online stores. Based on research, the sample size of 12 to 50 participants is considered adequate for qualitative behavioural research (Sworkin, 2012; Boddy, 2016). This research had thirty-six participants (18 offline store participants and 18 online store participants). Every participant received a USD 10 voucher for taking part. Informed consent was received to use the eye tracker while shopping. Despite the attempt to convince potential participants to use the eye tracker, many customers refused participation on these grounds.

The research looked for participants who wanted to shop for cosmetic products at each store location. They were asked to put on the wearable eye tracker before entering the store. The participants shopped as they liked as the research did not intervene in the shopping process aiming to get a natural experience. The data gathering procedure for each participant is given in Fig. 2.

In the pre-interview phase, the participants were checked against the research criteria, and their prepurchase experience was explored. Then, the wearable eye tracker was attached, and participants were asked to shop as they wanted. They were allowed to shop as long as they wanted and to change their shopping list if needed. During the shopping phase, the customer journey map was made. Once the shopping was done, eye movement videos were watched asking to explain the think and feel from one event to another. This RTA phase helped to explore the purchase experience in detail based on an eye-tracker video. The last phase conducted an In-Depth Interview to explore the overall experience from the prepurchase to the post-pur-

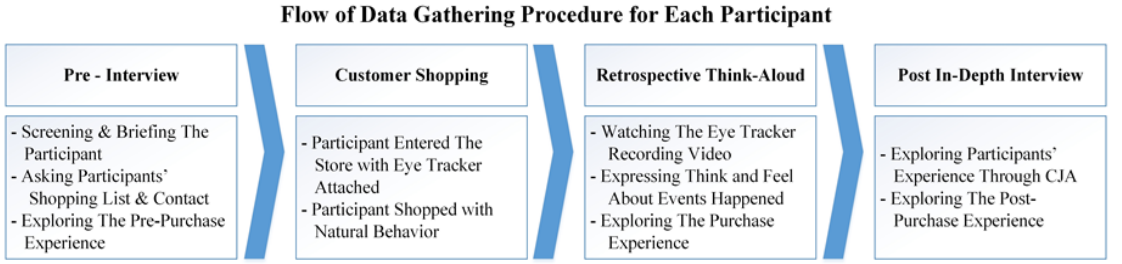


Fig. 2. Data gathering procedure for each participant

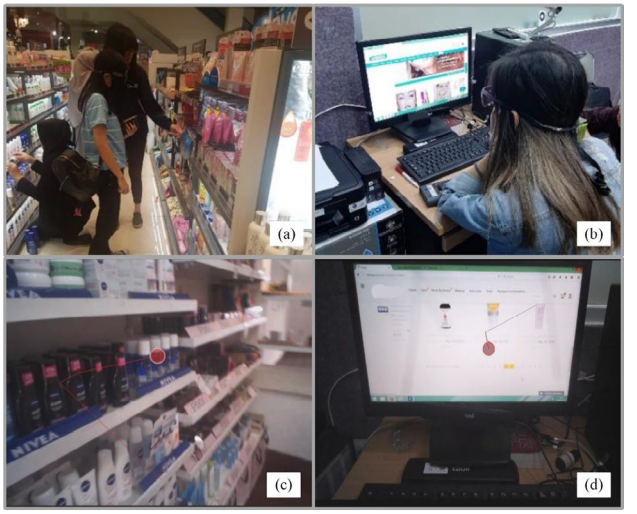


Fig. 3. Data gathering process: (a) an offline store; (b) an online store; (c) eye movement in an offline store; (d) eye movement in an online store

chase based on the created customer journey map. These four phases were iterated for each participant from each cosmetics retail store.

The data gathering process for offline stores was held in the cosmetics store where the shopping took place, whereas online store data gathering was held in the place where the customer usually used their device for shopping (e.g., at home, school etc.). This field study aimed to capture the real and natural experience. The examples of the data gathering process can be seen in Fig. 3.

Before conducting the data collection, the pilot study was made to ensure that the data gathering procedure and the result would meet expectations. The pilot study was made using the real data gathering process. The pilot study was conducted with four participants (two for an offline store and two for an online store). The pilot study demonstrated that all procedures and results were good. However, the pilot study helped to eliminate participants with eyeglasses because the eye tracker could not be used in such cases, and it was especially difficult to calibrate the eye movement of participants with cylindrical lenses.

This research used both qualitative and quantitative approaches to analyse customer experience from offline and online cosmetics retail stores. The qualitative data analysis used eye-tracking data (gaze replays and gaze plot) and customer journey maps as a basis for an in-depth exploration of the customer experience using RTA and IDI.

The quantitative data analysis used the time spent for every event captured by the eye tracker and compared the findings with the experience gained by the customers. The analysis was used to map factors that caused either a positive or a negative shopping experience.

3. Research results

This research used three kinds of eye-tracking data for customer experience, i.e., the gaze replay, the gaze plot, and time spent. The eye-tracking method was used to explore the purchase phase of the customer experience from the moment participants entered the store until the moment they left.

Gaze replay is a video recording from the eye tracker, which shows a real-time eye movement in the form of red dots for fixation and red line for saccades. Before entering the store, the eye tracker was attached to the participant's head to record real-time eye movements. During the purchase phase, the eye tracker recorded the user's eye movements, and the information heard. The gaze replay helped to explore all moments in the purchase phase of the customer journey in the cosmetics retail store. The gaze replay was used as the basis for conducting the Retrospective Think Aloud (RTA). For each participant, the RTA was conducted right after the participant finished shopping. The participants watched their gaze replay and expressed their think and feel about everything that happened during the shopping process. The combination of gaze replay and RTA helped to explore the customer experience in detail based on their cognitive (what they decided), behaviour (what they did), emotional (what they felt), and sensory (what they saw and heard) aspects.

A gaze plot is a map that contains a gaze sequence consisting of fixations and saccades of human eye movement from time to time during the data collection. This map was used to scrutinise some behaviours and sensory phenomena about the purchase experience in the cosmetics retail stores. This research found customer product searching patterns and items that attracted consumer attention. An example of the gaze plot data in this research is given in Fig. 4.

The third kind of data is the customer time spent on each activity while shopping (during the purchase

Fig. 4. Example of gaze plot data — a searching pattern of a customer

phase). The time-spent data was received from the eye tracker recording during the participant's purchase journey. This data was used to explore the customer experience related to cognitive and behaviour dimensions, especially how the customers spent their time in the cosmetics retail stores. Since data was collected at many offline stores, the selected stores had a similar floor area (80 – 120 sq. m) and a similar number of cashier queue lines (1 – 2 lines) to avoid the effect of store area differences that is related to the time-spent data. In addition, all participants had to have a shopping list indicative of their intention to purchase something from the store. The time-spent data for both offline and online cosmetics retail stores are given in Table 1.

The CJA used the Customer Journey Map (CJM) to systematically visualise and explore the experience by each step from the prepurchase phase until the post-purchase phase. Some information is provided in CJM for every journey of each customer, such as process names, customer goals, customer expectations, process flows, touchpoints, experience visualisation, customer's think and feel, negative experience, and positive experience.

Generally, the customer experience is significantly affected by the conformity between customer goals, customer expectations, and the reality that happened on any touchpoints in the process. The information from the CJM can be used to analyse the participant experience systematically.

Information was collected during the gaze replay video observation, the results of Retrospective Think Aloud (RTA), and the results of the In-Depth Interview (IDI), and presented in CJM. Customer characteristics were used to create eight personas (four for customers of an offline store and four for customers of an online store) to better understand the behaviour of participants. Personas were not created for each participant because of the similar characteristics of some research participants. Then, CJMs were created for every persona from each store to explore their experience. All CJMs were used to synthesise all relevant data to gather all customer experience and its design factors. The examples of CJMs from offline and online store participants are given in Figs. 5 and 6.

In many stores, the products are grouped based on the cosmetics brand. This arrangement makes it difficult to compare products by their type. Therefore,

Tab. 1. Time-spent data

Offline store						
No	Purchase phase journey	Time spent (sec)				
		Average	%	Std Dev	Min	Max
1.	Entering the cosmetics store	38.57	3.13	10.80	15.04	76.75
2.	Exploring the products in the store	589.45	47.80	576.20	215.36	1339.07
3.	Finding some product information	202.37	16.41	80.76	57.23	237.42
4.	Exploring product testers	127.00	10.30	12.54	35.08	167.78
5.	Interacting with the shop assistants	67.85	5.50	19.00	0.00	98.38
6.	Entering the cashier's queue	94.00	7.62	63.22	0.00	184.90
7.	Making a transaction	88.45	7.17	41.32	32.77	147.21
8.	Leaving the cosmetics store	25.55	2.07	12.01	9.71	37.56
Total purchase phase		1233.24	100	942.64	421.29	2398.50
Online store						
No	Purchase phase journey	Time spent (Sec)				
		Average	%	Std Dev	Min	Max
1.	Opening the online store apps	24.52	0.87	16.67	6.87	46.53
2.	Exploring the store's interface	1397.68	49.80	529.23	259.63	2,205.57
3.	Exploring related information	472.56	16.84	324.13	145.30	777.47
4.	Comparing products with other stores	292.66	10.43	240.03	0.00	487.21
5a.	Registering account (for first-time user)	237.32	8.46	56.28	148.93	334.54
5b.	Log in (if already have an account)	26.10	0.93	24.01	6.26	38.63
6.	Filling the shopping cart & transaction	287.44	10.24	136.93	100.05	481.25
7.	Checking the purchase order tracking	68.40	2.44	19.81	32.26	81.47
Total purchase phase		2806.68	100	1231.14	896.93	3250.89

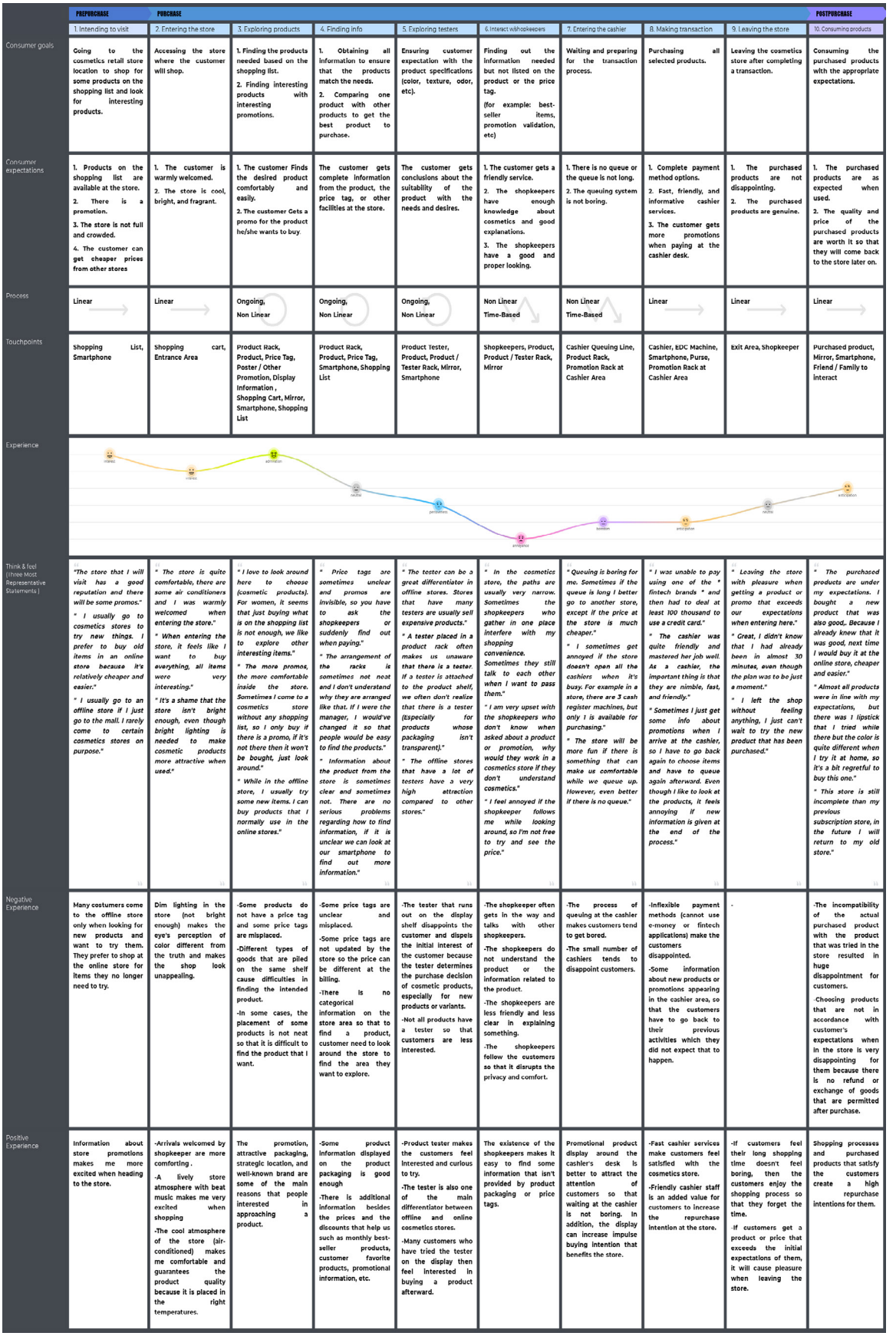
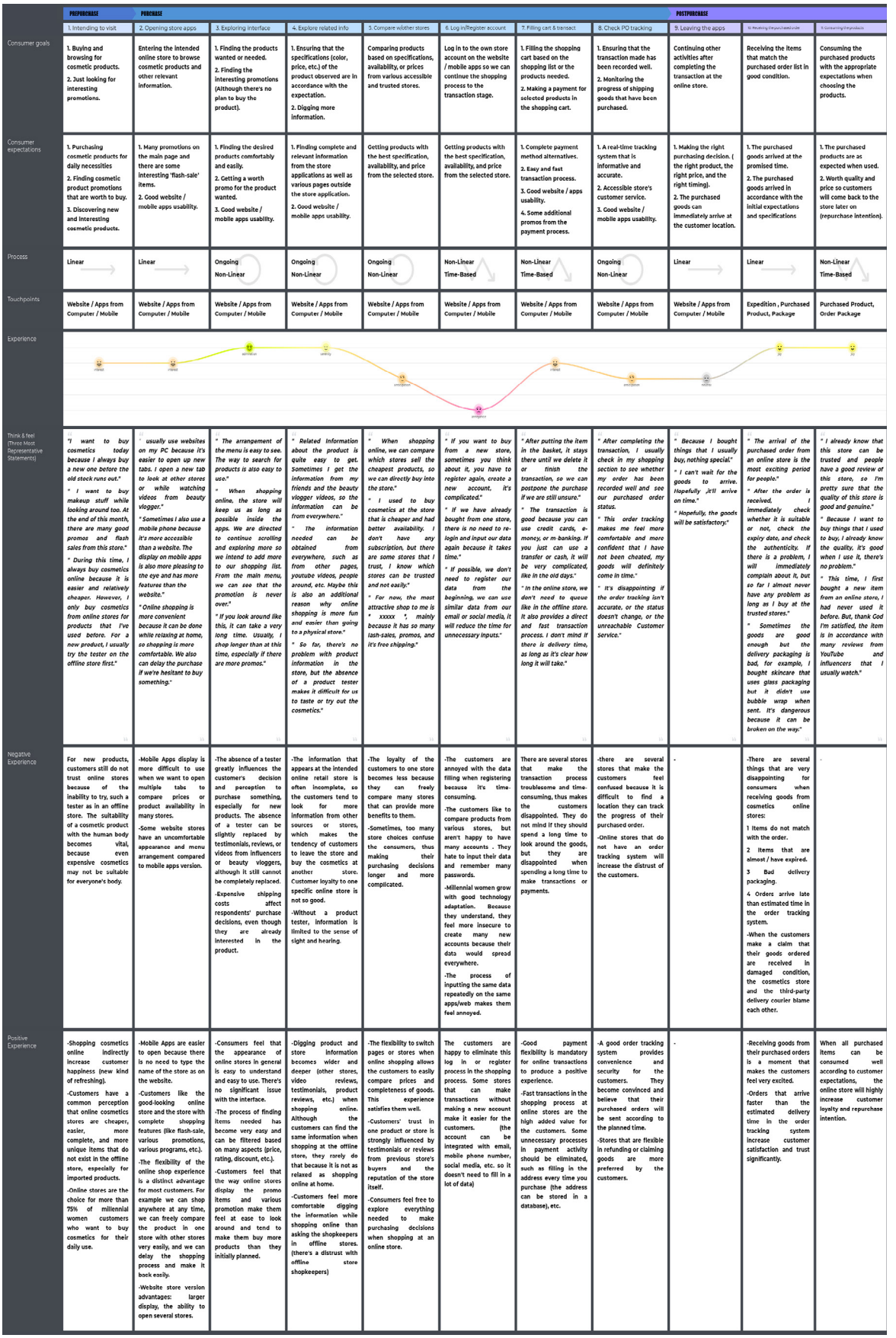


Fig. 5. Customer journey mapping example for an offline cosmetics retail store



	PREPURCHASE	PURCHASE					POSTPURCHASE				
	1. Intending to visit	2. Opening store apps	3. Exploring interface	4. Explore related info	5. Compare w/other stores	6. Log in/Register account	7. Filling cart & transact	8. Check PO tracking	9. Leaving the apps	10. Receiving the purchased order	11. Consuming the products
Consumer goals	1. Buying and browsing for cosmetic products. 2. Just looking for interesting promotions.	Entering the intended online store to browse cosmetic products and other relevant information.	1. Finding the products wanted or needed. 2. Finding the interesting promotions (Although there's no plan to buy the product).	1. Ensuring that the specifications (color, price, etc.) of the product observed are in accordance with the expectation. 2. Digging more information.	Comparing products based on specifications, availability, or prices from various accessible and trusted stores.	Log in to the own store account on the website / mobile apps so we can continue the shopping process to the transaction stage.	1. Filling the shopping cart based on the shopping list or the products needed. 2. Making a payment for selected products in the shopping cart.	1. Ensuring that the transaction made has been recorded well. 2. Monitoring the progress of shipping goods that have been purchased.	Continuing other activities after completing the transaction at the online store.	Receiving the items that match the purchased order list in good condition.	Consuming the purchased products with the appropriate expectations when choosing the products.
Consumer expectations	1. Purchasing cosmetic products for daily necessities 2. Finding cosmetic product promotions that are worth to buy. 3. Discovering new and interesting cosmetic products.	1. Many promotions on the main page and there are some interesting 'flash-sale' items. 2. Good website / mobile apps usability.	1. Finding the desired products comfortably and easily. 2. Getting a worth promo for the product wanted. 3. Good website / mobile apps usability.	1. Finding complete and relevant information from the store applications as well as various pages outside the store application. 2. Good website / mobile apps usability.	Getting products with the best specification, availability, and price from the selected store.	Getting products with the best specification, availability, and price from the selected store.	1. Complete payment method alternatives. 2. Easy and fast transaction process. 3. Good website / apps usability. 4. Some additional promos from the payment process.	1. A real-time tracking system that is informative and accurate. 2. Accessible store's customer service. 3. Good website / mobile apps usability.	1. Making the right purchasing decision. (the right product, the right price, and the right timing). 2. The purchased goods can immediately arrive at the customer location.	1. The purchased goods arrived at the promised time. 2. The purchased goods arrived in accordance with the initial expectations and specifications	1. The purchased products are as expected when used. 2. Worth quality and price so customers will come back to the store later on (repurchase intention).
Process	Linear	Linear	Ongoing Non-Linear	Ongoing Non-Linear	Ongoing Non-Linear	Non-Linear Time-Based	Non-Linear Time-Based	Ongoing Non-Linear	Linear	Linear	Non-Linear Time-Based
Touchpoints	Website / Apps from Computer / Mobile	Website / Apps from Computer / Mobile	Website / Apps from Computer / Mobile	Website / Apps from Computer / Mobile	Website / Apps from Computer / Mobile	Website / Apps from Computer / Mobile	Website / Apps from Computer / Mobile	Website / Apps from Computer / Mobile	Website / Apps from Computer / Mobile	Expedition , Purchased Product, Package	Purchased Product, Order Package
Experience											
Think & feel (Three Most Representative Statements)	*"I want to buy cosmetics today because I always buy a new one before the old stock runs out."* *" I want to buy makeup stuff while looking around too. At the end of this month, there are many good promos and flash sales from this store."* *" During this time, I always buy cosmetics online because it is easier and relatively cheaper. However, I only buy cosmetics from online stores for products that I've used before. For a new product, I usually try the tester on the offline store first."*	*" I usually use websites on my PC because it's easier to open up new tabs. I open a new tab to look at other stores or while watching videos from beauty vlogger."* *"Sometimes I also use a mobile phone because it's more accessible than a website. The display on mobile apps is also more pleasing to the eye and has more features than the website."* *"Online shopping is more convenient because it can be done while relaxing at home, so shopping is more comfortable. We also can delay the purchase if we're hesitant to buy something."*	*" The arrangement of the menu is easy to see. The way to search for products is also easy to use."* *" When shopping online, the store will keep us as long as possible inside the apps. We are directed to continue scrolling and exploring more so we intend to add more to our shopping list. From the main menu, we can see that the promotion is never over."* *" If you look around like this, it can take a very long time. Usually, I shop longer than at this time, especially if there are more promos."*	*" Related Information about the product is quite easy to get. Sometimes I get the information from my friends and the beauty vlogger videos, so the information can be from everywhere."* *" The information needed can be obtained from everywhere, such as from other pages, youtube videos, people around, etc. Maybe this is also an additional reason why online shopping is more fun and easier than going to a physical store."* *" So far, there's no problem with product information in the store, but the absence of a product tester makes it difficult for us to taste or try out the cosmetics."*	*" When shopping online, we can compare which stores sell the cheapest products, so we can directly buy into the store."* *" I used to buy cosmetics at the store that is cheaper and had better availability. I don't have any subscription, but there are some stores that I trust, I know which stores can be trusted and not easily."* *" For now, the most attractive shop to me is " xxxxx ", mainly because it has so many sale, promos, and it's free shipping."*	*" If you want to buy from a new store, sometimes you think about it, you have to register again, create a new account, It's complicated."* *" If we have already bought from one store, there is no need to re-login and input our data again because it takes time."* *" If possible, we don't need to register our data from the beginning, we can use similar data from our email or social media, it will reduce the time for unnecessary inputs."*	*" After putting the item in the basket, it stays there until we delete it or finish the transaction, so we can postpone the purchase if we are still unsure."* *" The transaction is good because you can use credit cards, e-money, or m-banking. If you just can use a transfer or cash, it will be very complicated, like in the old days."* *" In the online store, we don't need to queue like in the offline store. It also provides a direct and fast transaction process. I don't mind if there is delivery time, as long as it's clear how long it will take."*	*" After completing the transaction, I usually check in my shopping section to see whether my order has been recorded well and see our purchased order status.* *" This order tracking makes me feel more comfortable and more confident that I have not been cheated, my goods will definitely come in time."* *" It's disappointing if the order tracking isn't accurate, or the status doesn't change, or the unreachable Customer Service."*	*" Because I bought things that I usually buy, nothing special."* *" I can't wait for the goods to arrive. Hopefully it'll arrive on time."* *" Hopefully, the goods will be satisfactory."*	*" The arrival of the purchased order from an online store is the most exciting period for people."* *" After the order is received, I immediately check whether it is suitable or not, check the expiry date, and check the authenticity. If there is a problem, I will immediately complain about it, but so far I almost never have any problem as long as I buy at the trusted stores."* *" Sometimes the goods are good enough but the delivery packaging is bad, for example, I bought skincare that uses glass packaging but it didn't use bubble wrap when sent. It's dangerous because it can be broken on the way."*	*" I already know that this store can be trusted and people have a good review of this store, so I'm pretty sure that the quality of this store is good and genuine."* *" Because I want to buy things that I used to buy, I already know the quality, it's good when I use it, there's no problem."* *" This time, I first bought a new item from an online store, I had never used it before. But, thank God I'm satisfied, the item is in accordance with many reviews from YouTube and influencers that I usually watch."*
Negative Experience	For new products, customers still do not trust online stores because of the inability to try, such a tester as in an offline store. The suitability of a cosmetic product with the human body becomes vital, because even expensive cosmetics may not be suitable for everyone's body.	-Mobile Apps display is more difficult to use when we want to open multiple tabs to compare prices or product availability in many stores. -Some website stores have an uncomfortable appearance and menu arrangement compared to mobile apps version.	-The absence of a tester greatly influences the customer's decision and perception to purchase something, especially for new products. The absence of a tester can be slightly replaced by testimonials, reviews, or videos from influencers or beauty vloggers, although it still cannot be completely replaced. -Expensive shipping costs affect respondents' purchase decisions, even though they are already interested in the product.	-The information that appears at the intended online retail store is often incomplete, so the customers tend to look for more information from other sources or stores, which makes the tendency of customers to leave the store and buy the cosmetics at another store. Customer loyalty to one specific online store is not so good. -Without a product tester, information is limited to the sense of sight and hearing.	-The loyalty of the customers to one store becomes less because they can freely compare many stores that can provide more benefits to them. -Sometimes, too many store choices confuse the consumers, thus making their purchasing decisions longer and more complicated.	-The customers are annoyed with the data filling when registering because it's time-consuming. -The customers like to compare products from various stores, but aren't happy to have many accounts . They hate to input their data and remember many passwords. -Millennial women grow with good technology adaptation. Because they understand, they feel more insecure to create many new accounts because their data would spread everywhere. -The process of inputting the same data repeatedly on the same apps/web makes them feel annoyed.	There are several stores that make the transaction process troublesome and time-consuming, thus makes the customers disappointed. They do not mind if they should spend a long time to look around the goods, but they are disappointed when spending a long time to make transactions or payments.	-there are several stores that make the customers feel confused because it is difficult to find a location they can track the progress of their purchased order. -Online stores that do not have an order tracking system will increase the distrust of the customers.	-	-There are several things that are very disappointing for consumers when receiving goods from cosmetics online stores: 1 Items do not match with the order. 2 Items that are almost / have expired. 3 Bad delivery packaging. 4 Orders arrive late than estimated time in the order tracking system. -When the customers make a claim that their goods ordered are received in damaged condition, the cosmetics store and the third-party delivery courier blame each other.	-
Positive Experience	-Shopping cosmetics online indirectly increase customer happiness (new kind of refreshing). -Customers have a common perception that online cosmetics store are cheaper, easier, more complete, and more unique items that do not exist in the offline store, especially for imported products. -Online stores are the choice for more than 75% of millennial women customers who want to buy cosmetics for their daily use.	-Mobile Apps are easier to open because there is no need to type the name of the store as on the website. -Customers like the good-looking online store and the store with complete shopping features (like flash-sale, various promotions, various programs, etc.). -The flexibility of the online shop experience is a distinct advantage for most customers. For example we can shop anywhere at any time, we can freely compare the product in one store with other stores very easily, and we can delay the shopping process and make it back easily. -Website store version advantages: larger display, the ability to open several stores.	-Consumers feel that the appearance of online stores in general is easy to understand and easy to use. There's no significant issue with the interface. -The process of finding items needed has become very easy and can be filtered based on many aspects (price, rating, discount, etc.). -Customers feel that the way online stores display the promo items and various promotion make them feel at ease to look around and tend to make them buy more products than they initially planned.	-Digging product and store information becomes wider and deeper (other stores, video reviews, testimonials, product reviews, etc.) when shopping online. Although the customers can find the same information when shopping at the offline store, they rarely do that because it is not as relaxed as shopping online at home. -Customers feel more comfortable digging the information while shopping online than asking the shopkeepers in offline stores. (there's a distrust with offline store shopkeepers)	-The flexibility to switch pages or stores when online shopping allows the customers to easily compare prices and completeness of goods. This experience satisfies them well. -Customers' trust in one product or store is strongly influenced by testimonials or reviews from previous store's buyers and the reputation of the store itself. -Consumers feel free to explore everything needed to make purchasing decisions when shopping at an online store.	The customers are happy to eliminate this log in or register process in the shopping process. Some stores that can make transactions without making a new account make it easier for the customers. (the account can be integrated with email, mobile phone number, social media, etc. so it doesn't need to fill in a lot of data)	-Good payment flexibility is mandatory for online transactions to produce a positive experience. -Fast transactions in the shopping process at online stores are the high added value for the customers. Some unnecessary processes in payment activity should be eliminated, such as filling in the address every time you purchase (the address can be stored in a database), etc.	-A good order tracking system provides convenience and security for the customers. They become convinced and believe that their purchased orders will be sent according to the planned time. -Stores that are flexible in refunding or claiming goods are more preferred by the customers.	-	-Receiving goods from their purchased orders is a moment that makes the customers feel very excited. -Orders that arrive faster than the estimated delivery time in the order tracking system increase customer satisfaction and trust significantly.	When all purchased items can be consumed well according to customer expectations, the online store will highly increase customer loyalty and repurchase intention.

Fig. 6. Customer journey mapping example for an online cosmetics retail store

product-similarity based grouping is better for most customers than brand-similarity based grouping. It can help the customer to compare similar products and decide. Besides, the area information display is also a helpful tool for guiding the customer to the product they want. Information could be placed on many aisle intersections to guide the customers effectively. Some other factors affected the positive experience of the majority of customers while searching for products, including the availability and completeness of the product assortment, the relaxed atmosphere, and the attractive price or label.

The physical availability of a shop assistant is another main differentiator for offline cosmetics stores. The customer could ask for help and information needed from shop assistants. More than 75% of research participants using an offline store had interacted with shop assistants for at least one time during the purchase phase. They asked for information they failed to find on the display or the product, such as promotions, preferences, benefits etc. Therefore, shop assistants should have enough product knowledge and communication skills to bring a positive experience to the customer. However, shop assistants should not follow every single customer because it is considered annoying. Furthermore, shop assistants should avoid chatting among themselves in between the aisles as this was also annoying for customers.

Once the wanted products were selected, customers entered the cashier queue for the payment. On average, they needed more than one minute to wait in line. To prevent a dull experience, customer should be able to do something while waiting. For instance, promotional items or other exciting activities could be offered in the queue area to keep the customer busy.

Once the transaction is finished, a positive experience should be maintained until the customer feels satisfied with the purchased products. The post-purchase experience represents an important role in enhancing revisit and repurchase intentions. Besides maintaining the quality of all products, several things need to be considered by the offline store. Right after the transaction process, the customer interacts with the store packaging. The store packaging should be safe and attractive to make the customer feel that the store offers good quality and worth-while to revisit. After a while, the customer would open the package and use the products. The option to refund or return the product in the case of a store or supplier mistake would bring a more positive experience. These insights

Tab. 2. Customer experience findings for an offline cosmetics retail store

Phase	Customer experience (+/-)	Factors found
Prepurchase	1 engaged / unengaged	membership special treatment, special event (meet up, makeup training, give away, and more), company/brand reputation
	2 excited / unexcited	social media promotion, store location, past shopping experience in the store, new product alert
Purchase	1 convenient / inconvenient	product availability, product tester availability, completeness of information, arrangement of product placement, store area information display, payment method flexibility, self-service system, rack positioning and dimension
	2 comfortable / uncomfortable	presence of trained shop assistant, store and display lighting, tidy display, shopping cart availability and design, store temperature, store physical design concept, aisles width, self-service system, rack positioning and dimension
	3 enjoyable / unenjoyable	exciting music, store and display lighting, tidy display, cashier service and attitude, promotional product display on cashier area, shopping time spent
	4 interested / uninterested	store and display lighting, promotion variation and quantity, product availability, product tester availability, promotional product display on cashier area, price worthiness, rare or unique product presence
	5 satisfied / dissatisfied	price worthiness, product availability, product tester availability, completeness of information, arrangement of product placement, promotional product display on cashier area, cashier service and attitude, expired date suitability
Post-purchase	1 satisfied / dissatisfied	match between the purchased items and the expectation, refund and claim procedure, product guarantee
	2 happy / unhappy	price worthiness, repurchase promotion
	3 engaged / unengaged	repurchase promotion

are only some highlights of customer experience for offline cosmetics retail stores, while the summary is given in Table 2.

The technological development that can be easily adapted by millennial women provides grounds for the cosmetics online retail stores to thrive. Although the era of online cosmetics stores has not reached 15 years, all research participants had accessed at least one online cosmetics store, and 89% of them had shopped at an online store at least once a month. This shows an exceptional acceptance of online cosmetics stores. Based on their positive prepurchase perceptions, shopping at an online cosmetics store is easy, fast, cheap, providing a complete assortment of items, more promotions, unique items, besides, it is flexible and fun. Conversely, their negative prepurchase perceptions about shopping at an online cosmetics store were more cautious and related to fraud, being annoyed with long delivery lead time, afraid of a high shipping cost, and inability to test the product. 83% of participants intended to shop online to satisfy their daily cosmetic needs instead of finding new products they have never used. Product testing is one main reason for customer hesitancy to buy a new product. The majority of them had more shopping list items compared to offline participants. They said that they tended to buy more items from an online store because of shipping costs for each order and promotions. More than 50% of participants bought more items than initially intended on their shopping list.

Millennial women usually use a smartphone/tablet and a laptop/PC to access an online store, 72% of them prefer to use their smartphone/tablet. Some of the participants prefer to use smartphone/tablet because it is easy to use, easy to access, it has a better interface, and an autofill option of personal data like credit card data etc., while the rest prefer to use a laptop/PC because it is easy to open many tabs to compare many stores and it has a bigger screen. Compared with offline stores, the average time spent in an online store is much longer (46.8 minutes). This fact contradicts the perception that shopping online is faster. An online store interface encourages the customer to explore for as long as possible. Some features make the customer stay and explore longer, e.g., flash sales, thematic promotion, or personal suggestion based on user historical behaviour and purchase. Similarly to an offline store, some impulsive features should be used to encourage the customer to search and buy more.

The customers spent more than 30 minutes on average to find the products they wanted. However, some customers explored more than one store to compare some products, so their loyalty to one online store was lower. They also tended to explore some information outside the store to replace the unavailability of a product tester, such as viewing a testimony from other customers, watching videos from beauty influencers etc. Although they could also find that kind of information at the offline store, the customers felt freer and more flexible to access the information from the virtual environment when shopping online. The ability to save historical data also helped the customers, e.g., to save personal data (address, card number etc.) to avoid repeating the data input process, saving the shopping cart, saving preferences data to make suggestions during the next visit, and saving more information.

Even though the customers did not mind a long time spent at the online store, they felt annoyed with the long registration process. The step should be minimised to either register or login to be more satisfactory. The positive experience from the transaction process for online store emerges from fast steps, simple rules, flexible payment methods, and safe procedures. The parcel tracking system also has an important task to ensure that the customers are informed of their purchased order real-time status. This feature must be easy to find, easy to use and provide complete and accurate information.

For the post-purchase experience, timely and safe arrival of orders is one main reason for their repurchase intention besides the quality of items. The expiry date or year should be clearly indicated on all purchased goods to increase customer trust. The option of returning or refunding the purchased order also increases customer trust in repurchasing. These insights reflect only some examples of customer experience for online cosmetics retail stores, while the summary is given in Table 3.

4. Discussion of the results

Based on the analysis of offline cosmetics retail stores, recommendations were offered to improve the positive shopping experience. A store design represents the quality of sold goods. Millennial women have a positive experience (comfortable, enjoyable, fun) with cosmetics stores with many sensory attractions instead of typical retail design. For instance, a visually good-looking store with a trendy and modern concept, such as the Sephora design concept (CBinsight, 2021; Salpini, 2017), an attractive store

with scents that provide comfort or uplifting music. Millennial women also want full control in their shopping experience; hence, the preference of a self-service system. It should be remembered that shopping must be refreshing.

Store lighting and music have an important role in the sensorial experience while shopping, especially for cosmetics that have sensitive colour perception and mood. Ideal store lighting in a retail store can increase sales by 10% (Zumtobel, 2019). Moreover, bad lighting can blur the colour perception, hence disappointing the customer. The ideal lighting for women in retail stores is at a horizontal light intensity of 500 – 800 lux with a white temperature around 3000 – 4000 K. Spotlights can be used to highlight a product and direct the customers by increasing the attention and interest in certain products. Stores should provide enjoyable music to raise the mood.

Good product arrangement improves convenience for customer in finding and getting wanted products. Different types of products should not be piled up and blocked by testers. Store aisles should have categorised display areas based on product similarity (e.g., mask area, skincare area etc.) to guide

Tab. 3. Customer experience findings for an online cosmetics retail store

Phase	CX (+/-)	Factors found
Prepurchase	1 convenient / inconvenient	apps platform availability and flexibility, interface usability and simplicity, low Internet data usage
	2 engaged / unengaged	special treatment for members, push notification, personalised apps, special event (holiday promo, give away etc.)
	3 excited / unexcited	social media promotion, interface usability and simplicity, past shopping experience, new product alert, delivery fee, delivery speed and punctuality
	4 safe / unsafe	store trust issues, past review and testimony, past shopping experience, company/brand reputation
Purchase	1 convenient / inconvenient	product availability, interface usability and simplicity, completeness of information, arrangement of features placement, payment method flexibility, store review (from a beauty influencer, advertisement, end more), page transition speed and efficiency, product matching feature
	2 comfortable / uncomfortable	interface usability and simplicity, page transition speed and efficiency, customer service availability and readiness, completeness of information, product matching feature, payment method, product searching flexibility, registration or login procedure
	3 enjoyable / unenjoyable	promotion variation and quantity, rare or unique product presence, impulsive features, fun features (game, video, and more), time spent shopping
	4 interested / uninterested	promotion variation and quantity, product availability, price worthiness, rare product presence, delivery fee
	5 satisfied / dissatisfied	price worthiness, product availability, completeness of information, arrangement of features, expired date suitability, registration or login procedure, colour match between the picture and the real product
	6 safe / unsafe	registration and login, payment method, order tracking, customer service availability and readiness, product guarantee
	7 engaged / unengaged	promotion variation and quantity, special treatment for members, store review (from a beauty influencer, advertisement etc.), product availability, past review and testimony, past shopping experience, price worthiness
Post-purchase	1 satisfied / dissatisfied	match between the purchased items and the expectation, expired date suitability, refund and claim procedure, product originality, order tracking, delivery speed and punctuality, product guarantee, colour match between the picture and the real product
	2 happy / unhappy	price worthiness, delivery speed & punctuality, unexpected bonus item, packaging design
	3 safe / unsafe	packaging safety, received product condition, expedition handling procedure, order tracking, customer service availability and readiness
	4 engaged / unengaged	repurchase promotion and notification, personalised greetings (thank you, happy birthday etc.)

a customer. Product placement grouping based on product similarity is preferred over brand similarity, making it easier to compare similar products. Also, racks should not be placed too low or too hight and require the customer to bend down or reach up. Customers tend to ignore products displayed in the very bottom and top racks as this requires extra head movements.

Product and tester availability is one of the most important things for an offline store. An offline store has to benchmark many famous online stores because of the availability of its products. A product tester can bring a positive experience and help the customers see, feel, taste, match products to decide on their preferred choice. Besides, some features can be added to encourage the customers to continue exploring for as long as possible. An ergonomic shopping bag could be considered to help the customer to manage personal items while shopping. Besides the product tester, the main differentiator of the offline store is a shop assistant. A shop assistant acts as a support system to guide customers in achieving their goals. Therefore, shop assistants should be friendly, informative, knowledgeable, disciplined, and enjoyable. They should always be available to help but never follow the customers as this is considered annoying.

A simple and flexible payment system should be ensured. Cashless payment systems, such as credit cards, e-money, or fintech apps, should be provided to enhance customer transaction satisfaction. To prevent dull experience while queueing in the cashier lines, the customer could be kept positively busy. E.g., the cashier area could have promotion product displays, advertising screens or product testers etc.

Four other recommendations can be given about the marketing design. First, distinctive differentiators should be used to keep the store among the customer's preferences. Second, promotions should be varied more to motivate the customer to visit frequently. Third, the store should create the customer's key drivers (promotion, membership etc.) to encourage the revisit intention. Fourth, the store should consider establishing proper marketing mix strategies that consist of the best arrangement of the price, place, product, process, people, promotion, and physical evidence (Kotler et al., 2010; Braciníková & Matušínská, 2017).

The analysis of online cosmetics retail stores produced some findings and recommendations to improve the positive shopping experience. Since the customer has some common beliefs about online stores, as mentioned in the findings section, the positive perception could be used as a strong point of the store against the negative. Most customers were afraid to buy a new product from an online store because of the inability to test it. Thus, a substitute for a product tester should be offered, such as a review from a beauty influencer, a virtual tester using augmented reality etc. The concept of apps personalised based on activity history can also be used to make the customer feel pampered, i.e., offering a typical product recommendation for a specific customer, a special promotion based on customer purchase performance etc.

Seven typical recommendations are offered for an online store apps interface, which can enhance the positive user experience. First, it is advisable to provide a quick-picker feature for buying regular products to accommodate repeated item purchase. Second, page changes should be minimised as much as possible, especially for pages that require a long reload. Third, it is recommended to increase the search flexibility to find the intended product to give the customer many options. Fourth, all promotions and featured products should be displayed on the main page to encourage the customer to explore for as long as possible. Fifth, distinctive differentiators should be used to put the store among the preferences of the customer. Sixth, the store should provide a suitable store interface for different devices (smartphone, PC etc.) as customers have their own device preference. Seventh, the store should remain relevant by providing personalised notifications to buy daily necessities or offering access to related information. Also, the store should have a simple, interesting, and ergonomic interface design.

The service system of the online store should be developed, considering seven issues. First, the online store should provide a real-time order tracking system that is easy to use and accurate, this way providing a sense of security. Second, account register and login processes should be easy, fast, and safe. If possible, the account data should be integrated with other apps like e-mail, social media, or other stores to cut repeated actions.

Third, the store should provide complete information about the product to compensate for the inability to test the product directly. Fourth, stores should facilitate live interactions with customer service using either a real human operator or a chatbot. Fifth, the store should consider simplifying the refund or claim processes to enhance the post-purchase experience. Sixth, the store should enhance the payment experience with flexible, fast, and easy payment methods. Seventh, it is recommended to persuade the custom-

ers using many buying suggestions to encourage them to buy something new.

Four other recommendations about the marketing system of online stores can be offered. First, the store should determine the key market differentiators and develop them to become the key preference (e.g., the most frequently suggested by many beauty influencers, the best product availability, the price leader etc.).

Second, it should be beneficial to utilise social media and beauty influencers to build positive perceptions and trust of millennial women who are closely attached to the virtual environment. Third, the store should vary the promotional contents to encourage the intention of customers to visit. Fourth, the store should establish marketing mix 7P strategies (Kotler et al., 2010). And finally, to provide a better understanding of recommendations, Table 4 gives the comparison between them for offline and online cosmetics stores.

Based on the research processes and results, some advantages were found using the methodology. The methods were especially suitable for conducting customer experience exploratory research based on the customer's point of view.

Since the CX construct consists of five complex dimensions (cognitive, emotional, behavioural, sensorial, and social), these methods completed each other to explore all dimensions collectively. Moreover, the analysis used results in both qualitative and quantitative data to offer more insights and achieve the research goals.

Tab. 4. Comparison of the recommendations

Aspects	Offline store	Online store
Store design	Store design with many sensory attractions Proper store lighting, music, and temperature Good product arrangement with categorisation display area based on product similarity Tidy display Ergonomic and attractive product display Ergonomic shopping bag Promotional product display on cashier area Strategic store location Price or quality leadership	Positive imagery and trust of the store Testimony or a positive review from beauty influencer Advanced store features to overcome the tester unavailability (virtual tester, etc.) Price or quality leadership
Interface recommendation	-	Simple, usable, attractive, and personalised apps interface Quick-picker feature for repeated order Minimised page changes, especially for pages that require a long reload Flexibility of ways to find the intended product Displaying all promotions and featured products on the main page Bring up the distinctive differentiators Suitable store interface for different devices used (laptop, smartphone, tablet, etc.) Personalised buying reminder and suggestion Provide real pictures of the goods sold
Service system	Customer relationship (promotion variation, membership, etc.) Product and tester availability Fully-trained and friendly shop assistant; Flexible, fast, and easy payment system Easy refund and claim procedure Complete information about the product or store Self-service store	Customer relationship (promotion variation, membership, etc.) Product availability Live interaction customer service with either a real human operator or a chatbot Flexible, fast, and easy payment system Easy refund and claim procedure Complete information about the product or store; Real-time purchased order tracking system Easy, fast, and safe account register and login process Shipping and packaging safety

The methodology used in this research has some limitations. First, the obtained data is extremely diverse; thus, a researcher should have the required competence to draw conclusions accordingly. Second, the studied customer behaviour might be influenced by several biases, such as culture, economic condition, or previous confounding experience of the participants. Third, the data gathering process takes relatively long. Fourth, the factors found in this research have not been tested for statistical validity and reliability, which can be a subject for further study.

Conclusions

The research explained in this article analyses the idea that customer experience is a powerful differentiating company strategy to influence customers, especially for industrial sectors affected by hedonic aspects, such as e buying experience, emotion, or pleasurability. Customer experience research has become a popular issue during this decade. To date, the literature has shown some research about the detailed conception of customer experience and its impacts. However, this research offers an exploratory application of customer experience to support people and develop a positive customer experience for particular products/services/systems. The research raises important questions about how to explore customer experience factors and how to implement the customer experience for specific products/services/systems.

In previous research, customer experience positively influenced loyalty, repurchase intention, satisfaction, economic value etc. Based on the results of this research, customer experience showed a significant role on the customers of the cosmetics industry, which is greatly influenced by hedonic aspects. Since the extreme difference in characteristics could be a confounding factor in this research, millennial women were selected as participants being the largest market segment of the cosmetics industry. The customer experience of the cosmetics customers mostly emerged at the B2C cosmetics retailers with intense interaction between the customers and the cosmetic products/services/systems. The previous statement is in line with the findings regarding numerous customer experience factors that affect both offline and online cosmetics customers. The factors found in this research became the basis for making store design recommendations for cosmetics retailers.

The design recommendations of this research aim to support cosmetics retailers in developing their store differentiation strategy in the cosmetics market. The recommendations are given to offline and online cosmetics stores based on differences in customer experience. The research proposed some design recommendations for cosmetics retailers that consist of store design, interface design, and service system design. Also, it compared customer experience between offline and online cosmetics stores to support the retailers considering the routes to take.

For further research, the focus should be placed on a confirmatory analysis regarding the customer experience factors explored in this research. The CX analysis methodology could also use more work to help manufacturers develop their product or packaging design, support the retailers to improve their store design etc. The research methodology would be a new way to help people explore how to enhance positive CX for many cases, even though each method has its advantages and disadvantages. For the research process, more participants should be involved in further research to strengthen the analysis even though the time needed to analyse each participant's data using this methodology is somewhat long and uncertain. Moreover, it is essential to segment the customer appropriately based on the specific intended market. Customer experience dimensions are closely related to individual characteristics and behavioural differences. Care should be taken in separating which experience resulted from product, store, previous feelings, or other confounding parties to avoid any bias.

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Using the complexity index method to manage problems related to manufacturing

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ABSTRACT

The Complexity Index method is an approach developed to help manufacturing companies quantify complexity in production. This paper sheds light on the connection between complexity and manufacturing problems and how the Complexity Index method was used to capture the areas in a production line with high levels of complexity to determine the sources of manufacturing problems related to labour time, surplus production, and manufacturing error. The main areas perceived as complex were due to Work Instructions, Work Content, and Product Variants. The perceived complexities were assessed for proper actions to be taken to decrease their level of complexity. The correlations between complexity and manufacturing problems were used for tracking related issues and ways for improvement. This study presents data on the use of workers' perception to uncover the areas of complexity, which could be used by the management team to pragmatically capture difficulties and issues related to manufacturing problems to improve the production system.

KEY WORDS

complexity Index, perceived complexity, complexity drivers, and manufacturing problems

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Introduction

Companies in the competitive market strive to enhance their production by lessening manufacturing problems. Complexity is defined as the quality or state of something that is not fully understood or the lack of ability to perform a task easily. It plays a major role in many manufacturing problems and has a direct effect on quality.

There has been an increase in the complexity of production as the human–machine interface evolved

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in manufacturing industries, along with the change in the workplace environment and the ways tasks are done. The human–machine interface has become essential in today's manufacturing and resulted in many manufacturing problems. A human–machine interface is a complex interface and is not directly data-based, nor does it have a numerical matter. There is a need to find aspects that impact this interface, ways to calculate this impact as a quantitative matter and to understand its influence on the quality of a production line.

The Complexity Index (CXI) method was used in this study to enhance the overall efficiency of the factory and to eliminate or lessen the impact of problems during production by focusing on the human–machine interface, increasing the quality of the production line. Perceived complexity was the main focus of the study to reduce waste. The CXI method was used in this study to find the level of the perceived complexity of the production lines and the areas where complexity was perceived to be highest. Data were collected regarding the difficulty of tasks and manufacturing processes. These data were analysed to measure complexity and find reasons and major aspects that lead to production deficiency, and find ways to relate this measurement to various manufacturing problems for enhancement.

1. Literature review

In any manufacturing system, the understanding of the causes of complexity is challenging. Increased transparency of the complexity within the factory can help to identify problems related to manufacturing. Budde et al. (2015) stated that to gain an understanding of the complexity, the causes of complexity need to be identified first, and their dependency on products and processes will be described subsequently. Sivadasan et al. (2006) defined complexity in a system as something that is "difficult to understand, describe, predict or control". Chryssolouris et al. (2013) stated that to manage and consider a complex system, the system complexity should be quantifiable.

As a reaction to the increasing market variety, methods to manage the product complexity are necessary during product development. Salminen et al. (2000) referred to product complexity as the number of product offerings aiming to meet diverse customer demands. Karlsson et al. (2013) saw that product variants were the main cause of complexity. Experienced operators might not look at instructions when new tasks are introduced; hence, work instructions have to be improved. Even production complexity is created by highly varied and customised products (Soltysova & Bednar, 2015); complexity can either be linked to products or production processes. Similarly, Trattner et al. (2019) reported that product variants and components have a negative effect on operational performance in terms of cost, time, and quality.

Mattsson (2013) defined production complexity as "the interrelations between product variants, work content, layout, tools and support tools, and work instructions". Tarrar et al. (2016) studied the use of the complexity index in an automotive company to discuss work improvements. The finding was related to product variance with high complexity levels pointing to the wide variety of product produced and the high complexity levels in the layout, as well as the absence of ergonomics. Kohr et al. (2017) reported that complexity drivers, such as product structure and dynamics of technology, influenced the discrete manufacturing industry. Li et al. (2018) reported that operator performance in terms of perceived cognitive workload and information quality was affected by the presented content of information in work instructions.

Lean production tools are widely used in manufacturing industries to identify and eliminate problems in production (Sony, 2018). Soliman et al. (2018) indicated that lean production in a complex sociotechnical manufacturing system has some impacts that reduce complexity while other impacts imply an increase, suggesting that lean production can be an effective way of balancing complexity attributes. Riesener et al. (2019) presented a methodology for the identification of complexity-relevant information requirements for analysis and visualisation of product and service complexity. Ukala and Sunmola (2020) used a rule-based approach to improve the complexity of product assembly.

Mattsson et al. (2012) and Gullander et al. (2012) used a method called the Complexity Index (CXI) to describe the complexity levels. Furthermore, Mattsson et al. (2012) used the CXI method to identify sources of task complexity and solutions to the problems faced by manufacturing companies in the areas of complexity, anthropometry, the safety of the workstation, expertise, and knowledge of a worker to deal with the task. Similarly, Mattsson et al. (2014) stated that the CXI measurement was based on the definition of production complexity, where focus areas included product variants, work content, layout, tools and support tools, work instructions and the general

view of the station. However, studying how the employees perceive their work is crucial to successfully manage and design the system (Grote, 2004; Mavrikios et al., 2007). Mattsson et al. (2018) used CXI to capture the operators' view of a system for managing production complexity in a production system. Johanson et al. (2016) studied manufacturing companies that face vulnerability in quality of production when a variety of a product is being produced. They reported that production variation was directly related to perceived complexity. The manufacturing of product variants in manual assembly was challenging since the operation of product variants tended to increase the perceived complexity for the operator.

2. Research methods

2.1. Case study

The factory used for this study is considered a medium production facility in Lebanon. Their products range from mechanical equipment to power generators. The majority of the production systems are carried out manually, which requires human interaction with machines. The other production is semi-automatic, with workers overseeing the process. Every station has a group of workers assigned to deliver the final product. In this pilot study, problems reported during production were related to the MUDA type of waste (Ohno, 1998) and to waste skills (Liker, 2004). In this study, three problems were the main concern for the production and operator managers. They were classified according to:

- Time: this type of problem resulted from a large number of employees working in the factory. For manual production systems, workers have an excess of idle time waiting for the machines to complete the assigned job. Additionally, for the semi-automatic system, time was wasted as workers who oversaw the production were waiting for the job to end.
- Surplus production: this problem was due to the large number of products the company makes. Each product has its own production technique and finishing process. Even though instructions were available, the employees planned and performed their work mostly based on their experience/know-how. This led to ambiguity in quantifying the number of finishing products produced.
- Manufacturing error. This problem was related to a high number of variants and customised orders. The employees handled special customer orders based on their intuition because, in some cases, they neither had the design nor the knowledge. These customisations led to a complex production, which affected the quality of the final product.

2.2. Methodology

The CXI method gives an index for a production line stating how complex it is regarding a few aspects of the work (focus areas). A set of questions concerning certain focus areas that might be perceived as complex was handed out to the workers for answers. Those answers were used to calculate the complexity index of each focus area (CXIe) using the following equation (Mattsson, 2013):

$$CXI_e = \frac{\sum_{P=1}^{n} M_{ep}}{n} \quad (1)$$

where CXI_e = CXI for focus area e, M_{ep} = median of the questionnaire answers for problem areas e for respondent p, and n = number of respondents. The CXI for each production line was calculated by adding the median for CXI_e to the highest median for all focus areas complexity divided by four. The CXI for each production line was calculated using the following formula (Mattsson, 2013):

$$CXI = med_{e=1\ldots k}\, CXI_e + \frac{max_{e=1\ldots k}\, CXI_e}{4} \quad (2)$$

The second part of the formula makes sure that high values of problem areas are captured, i.e., individual differences are captured in the station CXI. Here, the highest median for all problem areas (the maximum median) is taken and divided by four (the highest median can be five as the statements are rated from 1–5, which means that if a five is the highest median, the second factor will be 1.25) (Mattsson, 2013). To visualise the complexity index, the scores from the statements are divided into three categories:

- $0 < CXI < 2$ (no change needed),
- $2 \leq CXI < 3$ (need to change),
- $3 \leq CXI$ (urgent need to change).

2.3. Data collection

Data were collected from five different production lines to assess human–machine interactions and the effect of the working environment on the performance of workers. Each of these production lines

Tab. 1. Overview of production lines and the number of workers

Production Line	A	B	C	D	E
Number of Workers	7	5	10	8	8

consists of several stations. The variation in the number of workers provided the study with the variability that may be found in production lines when it comes to the number of workers needed to do a certain task. The number of workers assigned to each production line is presented in Table 1.

A survey of 58 questions was carried out to assess the complexity level in each production line. The survey was distributed to workers to measure the level of complexity of tasks they are assigned to. The survey answers were based on a Likert scale (1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, and 5=Strongly Disagree). The questions were grouped into six focus areas (Fässberg, 2011):

1. Work Instructions. Work instructions are used to help workers in their daily work. They are vital for the measurement of complexity because instructions simplify the task and give direct information on how to perform it efficiently. They are step-by-step guides to perform the job. The absence of work instructions or provided obscure instructions may complicate a task.
2. Product Variants. It relates to the number of product variants and/or customised products during production. The product variability implies a higher complexity for the operators since a higher number of variants has a negative effect on productivity and is challenging to the overall manufacturing performance.
3. Tools and Support Tools. Tools and support tools are related to the type of tools workers have on the production line and if they help the operators in their work. Poor tool design leads to fatigued, frustrated and injured workers, which leads to a more complex workplace.
4. Work Content. The operator must know what to do when they come to the station and the assigned tasks. Experience plays a major role since more experienced workers generate less waste and produce better-quality products. Work knowledge and experience have a major effect on the complexity level of the task.
5. Layout. It relates to the layout of the production line and ergonomics. It involves the allocation of space and the physical arrangement of equipment to achieve the greatest coordination and efficiency of workers and workplace interaction. Layout plays a major role in how workers perceived complexity; it also directly affects the general quality of the production line and the manufacturing process itself.
6. General View. The general view is the broad image of the workplace. It reflects how the workers generally perceive the production line they work at and if it is possible to comment or suggest improvements. It helps to understand the general overview of the level of complexity of the production line.

3. Results and discussions

3.1. Complexity

Table 2 displays the CXI values derived from the surveys. These values show the complexity in each focus area and their contribution to the overall CXI of each production line. The calculated total CXI values show the areas and production line in the factory with higher levels of perceived work complexity and difficulty.

Tab. 2. Complexity level in the production lines

Focus area	Production line				
	A	B	C	D	E
Product Variants	1.9	2.9	3.5	2.1	4.6
Tools and Support Tools	2.7	2.8	2.2	1.3	2.9
Layout	2.4	2.4	1.4	1.3	2.7
Work Content	2.3	4.5	2.1	1.2	3.9
Work Instructions	2.2	3.6	3.5	2.1	4.4
General View	1.7	2.6	2.1	1.6	1.6
Total CXI	**2.93**	**3.98**	**3.03**	**1.98**	**4.55**

The differentiation in the CXI levels of each focus area reflected the general difference in every production line. The results presented in Table 2 show clearly that the complexity level in most of the focus areas is somewhat moderate ($2 \leq CXI < 3$) to high ($CXI \geq 3$). Also, it shows that station E has the highest CXI levels with a total CXI=4.55. This means that station E is the most critical, and actions must be taken immediately. Next in line are stations B and C with CXI=3.98 and CXI=3.03, respectively; this implies that both stations have high complexity levels and need immediate attention as well. Station A has moderate complexity levels with CXI=2.93 that need swift attention and actions to decrease the complexity level before it becomes critical. Station D has low complexity levels with CXI=1.98, which implies that workers do not perceive this station as complex, and it needs little attention to keep the complexity level within the range of being low.

Every production line needs a different approach to reducing waste, enhancing the quality of the production, and improving the factory's overall efficiency. Actions and improvements must start with the production line that has the highest levels of complexity. Actions and improvements must be more specific and must begin with the focus areas that score the highest levels. Table 2 clearly shows that:

- Production line E has remarkably high overall perceived complexity, which has a major effect on production. It has three focus areas with high levels, two with moderate levels, and one with low levels. This production line should focus more on making the workspace simpler and more acceptable for the workers to perform better. A focused improvement to Work Instructions, Product Variants, and Work Content focus areas must start immediately to lower the complexity level. After focusing on the high complexity level areas, the management focuses on the moderate level areas since they are not in the safe zone and might have a major role in the high overall complexity levels. This will be carried out by a gradual improvement in Tools and Tool Supports and Process Layout for an efficient and effective change in the complexity.
- Production line B has the second-highest complexity levels with two focus areas in the high-level zone, four in the moderate and zero in the low zone. This means that production line B has to improve all the aspects of the problem and immediately lower the complexity levels. By having zero problem focus areas in the low CXI levels, it is suggested that intensive adjustments and supervision must be exercised to help workers and to simplify the tasks.
- Production line C has the third-highest CXI levels with two focus areas in the high complexity zone, three in the moderate, and one focus area in the low zone. This means that complexity is unstable. It is suggested to work on the product variants and work instructions immediately to maintain a suitable CXI level.
- Production line A has an overall of moderate complexity levels with four focus areas in the moderate CXI levels and two in the low zone. The production line has moderate complexity levels, needs attention and requires actions to be made to decrease the levels, just not as immediate as with production lines with high overall CXI levels. However, having four focus areas out of six in the moderate area imposes a possible future threat of the levels increasing; therefore, it is suggested that actions should be taken to improve the overall quality of production and decrease the complexity.
- Production line D has the lowest CXI level and requires no actions to be taken. This wasn't surprising as production line D is a mainly semi-automatic system and has minimal human–machine interference. However, some moderate complexities were perceived in two focus areas, which were the result of missing instructions for new or customised products.

3.2. Production deficiency

The complexity levels per focus area show how complex each of them was regarded and their contribution to the overall CXI. Table 3 lists in descending order the focus areas that are the main contributors to the complexity and how these focus areas are correlated to the manufacturing-related problems within the factory.

Table 3 shows that Work Instructions is the main contributor to complexity for all the production lines compared to other focus areas. The answers to the survey on Work Instructions reported unclear instructions, lack of support, and difficulty understanding and obtaining work instructions.

This is vital considering that production is facing the challenge of delivering several variant models on time. The outcomes of this study show clearly that the main contributor to many manufacturing problems for all production lines is the absence of clear work instructions.

Tab. 3. Complexity levels of focus areas and their effect on problems related to manufacturing

Focus area	Complexity level			Production-related problem		
	High	Moderate	Low	Time	Surplus Production	Manufacturing Error
Work Instructions	3	2	0	✓	✓	✓
Product Variants	2	2	1	✓		✓
Work Content	2	2	1	✓		✓
Tools and Support Tools	0	4	1	✓	✓	
Layout	0	3	2	✓		✓
General View	0	2	3			✓

The results of Product Variants and Work Content are similar to Work Instructions, where both focus areas have a high level of complexity. This is a drawback considering that all production lines have complexity problems related to product variants and work content. It is believed that the lack of experience and the demand for customised products contribute to the high complexity. In many cases, customised products are considered variants even if they are similar to each other and consist of similar components since they require different manufacturing techniques. The factory faces the challenge of delivering an increasing number of variants and models. Operation managers must be aware that variants require different strategies for production and are challenging to manufacture; additionally, they require highly skilful and experienced workers. Complexity in product variants and experience can magnify issues related to many manufacturing problems as the tasks the operators perform take a relatively long time, and errors in production are irrepressible.

Four production lines showed moderate complexity driven by the focus area Tools and Support Tools. There was a lack of effort to ensure all needed tools and items were available at each production line. The respondents stated that the production line was acceptable for work; however, in some cases, the needed tools to complete a work process were removed from the work area and used at another production line. This contributes to problems related to time wastage. In other cases, workers might increase the volume of production to compensate for any manufacturing error before returning the shared tools to another production line. This also contributes to problems related to surplus in production.

The complexity result of the focus area Layout was similar to the focus area Tools and Support Tools, where both focus areas showed some concern level of moderate complexity. The respondents stated that the production line was well designed for work. Nonetheless, problems were reported in relation to inadequate work preparation and ineffective removal of unnecessary tools and materials from the work area. Insufficient clearing and cleaning can increase problems as tasks performed by operators become lengthy, and errors in production start to creep up.

The focus area General View has the lowest complexity level and the least effect on the waste-related problem. Even though worker feedbacks were perceived as good, two production lines encountered manufacturing errors. The workers' responses to the questions related to this focus area showed workplace contentment and satisfaction but also reported the absence of engagement in decisions related to improvements and the opportunities to resolve work-related problems. This clearly contributes to manufacturing errors.

This section discusses the possible use of CXI results to improve production. Improvements should focus on workers, workplaces, and managers. Based on CXI results, the most important areas of complexity in all production lines are Work Instructions, Work Content, and Product Variants. This is important considering that production faces the challenge to reduce problems related to labour time, surplus production, and manufacturing error. The lack of experience and the introduction of more variants and customised models have been major contributors to complexity. To be more precise, production lines that have the highest complexity index revealed problems related to rework, repeated movement of the operators from machines to the materials rack and waiting time. Operation managers must give valuable information and instructions to workers regarding possible difficulties imposed by such actions on manufacturing. Poor communication and training within the factory were important contributors to poor results in complexity.

The focus area Tools and Tool Supports addresses issues of labour time and inventory. The surveys

stressed problems related to the availability of tools and parts. Operation managers must ensure that workers have everything to accomplish the task efficiently. Workers must be provided with needed information and adequate time to finish their job. Additionally, planners must make the station free of unplanned changes or uncertainties, and if not possible, they must provide workers with time to adjust and offer technical assistance if needed.

The complexity in the focus area Layout contributes to the increase in production time and manufacturing error. The issues with Layout resulted from the lack of efforts on material preparations for production and housekeeping concerning the work areas. The survey provided sufficiently detailed information regarding reasons or causes of time-wasting and manufacturing errors. The situation is purely logistic and needs improvement. To reduce problems related to manufacturing, the job design phase should consider information on organising the movement, preparing the work areas, and ergonomic aspects.

The results of the focus area General View outlines how operators feel about their work. It concerns the wellbeing (physical or mental) of staff. Managers must consider the involvement of workers in evaluating the current situation and finding issues in need of improvement. This involvement makes the tasks less stressful and provides workers with the technical information needed to minimise defected, reworked, or recycled products.

Conclusions

This study aimed to investigate how perceived complexity could be used in the manufacturing industry with serious production issues. Using CXI as a complexity measurement tool to reveal complexity drivers and resulting complexity effects, this study presented data on workers' perception to uncover the areas of complexity. The CXI method was found to be extremely useful for seeking workers' feedback and effective in showing their insight into work conditions. The staff contribution helped to point out operation and layout problems of a production line.

The complexity measures of the six focus areas were good predictors for the impact made by inadequate complexity on workers, products and production. The results of the evaluation of these focus areas on production deficiency allowed the management team to define the focus areas that were the main contributors to complexity in production and how these focus areas were correlated to the problems related to manufacturing. The main areas perceived as complex were due to Work Instructions, Work Content, and Product Variants. Consequently, the management team must ensure that workers have everything (instructions, training, etc.) to accomplish the task efficiently. The results of this research can be used to provide improvements and reduce and/or handle production problems. Also, they allow the management team to ascertain an adequate complexity for workers, the workplace and the process.

The outcomes of this study showed significant correlations between complexity, ergonomics, and experience of workers and provided quantitative methods for tracking the quality-related issues and ways for enhancements. The correlation used in this study can aid the management team in pragmatically capturing difficulties and issues related to manufacturing problems. Poor communication was a key variable that led to poor results in complexity. The management team must consider involving workers in the process of evaluating and anticipating problems and determining actions that lead to the desired outcomes or objectives.

In summary, the CXI method can help in the assessment of suitable actions to enhance the issues faced by the factory. This method gives a better insight into the direct relationship between the efficiency of the process and the aspects of human interaction with machines (Complexity, Ergonomics and Experience).

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Empirical study on mental stress among healthcare staffs and the influencing workplace stressors

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ABSTRACT

This study provides empirical indicators on the presence of alarming mental stress levels among healthcare staffs as a result of the work environment. The study uses a comprehensive survey to identify work stressors and to addresses stress symptoms and coping behaviours among the healthcare givers in Jordan as a case study. The study aims to direct management's attention to work conditions that largely contribute to increasing mental stresses among their healthcare staffs. Moreover, the study identifies out stress symptoms that employees, team leaders and managers should not ignore to help their fellow workers cope with their stresses through legitimate coping behaviours. A total of 300 responses from 176 nurses, 45 technicians and 79 physicians from three hospitals with high patient flows were included in the statistical analyses. Results demonstrate that stressors related to high job demands, especially long working hours, have the highest impact on the development of stress among surveyed caregivers. Job-demand stressors were the most significant predictor of the symptom recurrence level with a $\beta = 0.334$. Continual tiredness and frequent headaches were the most frequent stress symptoms. Taking unprescribed medications, smoking tobacco, and faking reasons to take time off were the most common behaviours to relieve stress. This study contributes to the literature theoretically and practically. From a theoretical perspective, the study provides a comprehensive survey that captures the symptoms, relieve behaviours and work-related causes of stress. From the practical perspective, the study helps care providers and healthcare managers address and resolve work stressors and help their staff adopt healthy behaviours to relieve their stresses.

KEY WORDS

work stress, mental stress, work stressors, healthcare, ergonomics

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Introduction

Work is a primary source of income for many individuals. An ergonomic work environment enhances the safe interaction between the worker and other components of the work system. Unsafe work conditions may result in negative consequences on the physical and mental health of the worker (Gartner et al., 2010; Haque, Sher & Urbański, 2020; Sariwulan, Capnary & Agung, 2019). Work-related mental stress is a worldwide epidemic that negatively affects organi-

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sations and employees, especially in healthcare professions. Mental stress can negatively affect the health and behaviour of workers, especially when the psychological ability consumed by continued stress exceeds the level to which the worker's body can accommodate (Conway et al., 2008).

Some professions are inherently more stressful than others, especially those that involve human contact and require rapid decision-making, especially when those decisions have serious impacts (Muncer et al., 2001). The healthcare environment often implicates high levels of acuity of patients and rapid change conditions that make medical care processes complex. Even for highly experienced caregivers, this complexity usually is coupled with the potential for medical errors and inherent human performance limitation. Accordingly, healthcare professions are considered some of the most stressful jobs (Favrod et al., 2018). Patient-care professionals or healthcare givers experience higher levels of mental stress compared to other workers. Healthcare givers are responsible for delivering high-quality, safe, timely, and equitable services to patients. They are required to meet the cognitive demands necessary to administer complex treatments and medicines. They are expected to respond to patient emotions and face patient deaths. In addition, they are required to cope with the rapidly changing environment and work conditions. Literature provides empirical evidence on the adverse consequences of work-related mental stress on the well-being of caregivers that manifest in the form of illness, adverse behaviours, as well as poor job satisfaction, the impact on patient health due to medical errors and impaired quality of care, and consequently, negative effects on a healthcare organisation because of reduced quantity and quality of work.

This study presents findings of a self-administrated survey dedicated to identifying work stressors with the most impact on Jordanian healthcare givers. In addition, it surveyed healthcare givers for stress symptoms, the impacts on their ability to work, and their coping behaviours to relieve stress. Female and male healthcare givers with various job titles and years of experience from different care units were surveyed. The survey covered three major hospitals with high patient flows in northern Jordan. The hospitals are located in different cities and serve large numbers of in- and out-patients every day. The study hypothesises that several combinations of stress symptoms that indicate a level of mental stress that needs attention can be traced by individual caregivers, their fellow workers, and healthcare managers to help preserve the well-being of staffs. Moreover, the study hypothesises that individuals suffering from stress symptoms may incline to illegitimate coping behaviours to help their selves reduce the symptoms they suffer. Furthermore, the study hypothesises that several workplace conditions, including many managerial practices, largely contribute to increasing stress among staffs. This study contributes theoretically and practically to the literature. From a theoretical perspective, the study provides a comprehensive survey that captures the symptoms, coping behaviours and work-related causes of stress. From the practical perspective, the study helps care providers and healthcare managers address and resolve work stressors and help their staff adopt healthy behaviours to relieve their stress. This study calls upon healthcare managers to better account for the mental health of their staffs while modifying strategic policies and procedures.

The remainder of this paper is organised as follows. Section 2 reviews the literature on work-related stressors and stress symptoms among healthcare givers. Section 3 presents the study method. Results are presented and discussed in Section 4. Section 5 concludes the paper.

1. Literature review

Stress is an unavoidable aspect of the work environment and a product of the interaction between a person and his/her environment. The World Health Organization (WHO) classified occupational stress as a worldwide epidemic (Avey et al., 2009). According to Hamdan-Mansour et al. (2011), stress is any physical or psychological demand beyond the norm that indicates a variation between what is optimal and what really exists. Suresh et al. (2013) defined stress as the particular relation between the person and the environment that arises when exceeding the person's resources as well as threatening his/her well-being. In the literature, the Demand Control Model (DCM) and the Effort–Reward Imbalance (ERI) model are used to explain the causes of work-related stress. According to Laschinger et al. (2001), DCM states that any work that combines high job demands with low control is predicated on causing a high level of job stress with psychological and physical consequences. Job demands are the psychological stressors present in the work environment. Examples of job demand include work volume, work pace, level of difficulty, level of concentration needed, and the presence of conflicting demands. Decision control consists of skill discretions

that develop the individual's special abilities and decision authority that authorises the individual to make work-related decisions. On the other hand, the ERI model states that mental stress and its health consequences arise when a high degree of effort is not reciprocated with adequate rewards in the form of pay, status and opportunities for advancement (Calnan et al., 2016). To decrease the negative consequences of work-related mental stress on healthcare workers and their organisations, many researchers proposed various interventions, including the Mindfulness-based Stress Reduction (MBSR) approach, the Mindfulness-based Cognitive Therapy (MBCT) programme, the Mindfulness Self-care and Resiliency (MSCR) programme (Slatyer et al., 2017), and the Stress Management and Resiliency Training programme (SMART) (Werneburg et al., 2018). According to Werneburg et al. (2018), using SMART showed significant improvement in resiliency, quality of life, and health behaviours among participants.

Researchers believe that the experience of job stress has adverse consequences on the health of the workers, on their community, and on their organisations. Several researchers have reported many adverse physiological, psychological or emotional and behavioural consequences of work-related stress. Common physiological effects include but are not limited to headache, increase in blood pressure, palpitations or increase in heart rate, tightness in the chest, gastrointestinal upset, significant weight loss or weight gain, shortness in breath, cardiovascular disorders, neck–shoulder pain, stomach problems and sweating. Known psychological effects include nervousness, insomnia, anxiety, fatigue/exhaustion, lack of interest, feelings of worthlessness and hopelessness, low confidence, and burnout, a syndrome that combines emotional exhaustion, depersonalisation and low professional efficacy if stress levels exceed a person's ability to cope over an extended period. Behavioural symptoms include sleep disturbance, unhealthy eating, eating disorders, snapping and arguing with others, being fearful and aggressive, irritable and hyper startled response, absenteeism and turnover, difficulties of concentration and communication, alcohol and drug abuse and smoking (Freimann & Merisalu, 2015). Moreover, stress can reduce job satisfaction and, as a result, decrease commitment to the job, productivity, quality of work, and concern for safety, colleagues and the organisation. Moreover, stress may increase accidents and complaints from customers (Karadzinska-Bislimovska et al., 2014). In healthcare, Lin et al. (2007) showed that (49.6%) of nurses in a medical centre in Taiwan, who had high levels of stress, had experienced a primary headache. King et al. (2009) surveyed 435 nurses in the state of Ohio to examine the relationship between job stress level and disordered eating behaviours. The findings showed that the level of stress negatively affected eating behaviours and that nurses with a high level of stress and low level of body satisfaction had a higher level of disordered eating behaviours. Jordan et al. (2016) surveyed 177 full-time and part-time nurses in the USA to assess the combined impact of perceived stress and perceived coping adequacy on the health status and health behaviours of nurses. Feeling nervous, anxious, or on edge was the most reported symptom, and the group of high stress/poor coping nurses had the poorest health outcomes and the highest risk health behaviours compared to others. Gleeson et al. (2019) stated that work stress could be related to drinking alcohol and taking antidepressants or anxiolytics.

Several studies investigated the negative impact of poor work conditions on healthcare staffs. Studies investigated the influence of a personal profile, including the job function and work department, and stress. Banovcinova and Baskova (2014) suggested three categories of stressors in healthcare: personal (e.g., the incapacity to manage and control the work), interpersonal (e.g., relationships with doctors, managers, and co-workers), and stressors of working environment or organisational stressors (e.g., modern technology, workload, care for patients; in particular facing pain, suffering and death of patients, and the conflict of roles). Freimann and Merisalu (2015) used version two of the Copenhagen Psychosocial Questionnaire (COPSOQ II) to measure psychosocial work risk factors and mental health problems amongst 404 nurses at the university hospital in Estonia. The findings showed that work-related psychosocial risk factors with the highest mean scores were the meaning of work, role clarity, mutual trust between employees, and social relationships at work. Most indicators statistically correlated with stress and burnout and were in contrast with depressive and somatic symptoms. Moreover, social relationships at work, predictability, rewards, and trust in management correlated with all studied mental health problems. Quantitative demands, work pace, emotional demands, the meaning of work, role conflicts, role clarity, predictability, rewards, quality of leadership, social support from colleagues, social support from supervisor, social relationships at work, mutual trust between employees, trust regarding management, and justice and

respect were inversely correlated with stress, and all indicators were correlated with burnout except possibilities for development, role clarity, mutual trust between employees, and social inclusiveness. The authors suggested that there is an urgent need to amend current working practices to reduce the occurrence of mental health problems among nurses. Cheng and Cheng (2017) investigated the differences in psychosocial work conditions between a group of 19000 Taiwanese general workers and a group of 349 healthcare workers. The authors used the Chinese version of the Job Content Questionnaire to assess psychosocial work conditions and the five-item Brief Symptoms Rating Scale (BSRS-5) to assess the mental health status of participants. Results showed that healthcare workers have a higher prevalence of mental disorders than general workers. Moreover, lower justice, heavier psychological demands, experiences of violence, and job insecurity were associated with a higher risk for a minor mental disorder in healthcare workers. The authors suggested that authorities should account for psychosocial work conditions when discussing mental health problems in healthcare, provide support to the affected workers and encourage them to seek mental health treatments. Halpin et al. (2017) used the Nursing Stress Scale (NSS) to survey newly qualified nurses in the UK to determine work-related stressors over their first 12 months post-qualifying. Results showed that workload, inadequate staffing, and managing multiple roles were the most reported stressors. On the other hand, results indicated that being part of a good team provided a supportive and facilitative work environment. Gholamzadeh et al. (2011) surveyed a sample of 90 Emergency Department (ED) nurses from three large hospitals in Shiraz to investigate the sources of job stress and the adopted coping strategies. The authors investigated correlations among personal profile, including gender, years of experience, and marital status, sources of job stress, and coping strategies. Results showed that 86.7% of respondents were female between 23–50 years old, major sources of stress were problems related to the physical environment, workload, dealing with patients or their relatives, and handling their anger or aggressive behaviour, being exposed to health and safety hazards, lack of support by nursing administrators, and most common coping strategies were self-controlling and positive reappraisal. Callaghan et al. (2000) used the Anxiety Stress Questionnaire (ASQ) to investigate stress and coping among 168 nurses from different care departments in Hong Kong. Results showed that paediatric nurses reported the highest stress level, nurses at the lower grades reported higher stress levels than nurses at the higher grades, single nurses had marginally higher stress scores than married nurses, and females had slightly higher stress scores than males. In addition, major stressors were nursing issues (38.1%), including too much work, dealing with emergencies, and responsibilities inherent in the job, interpersonal relationships (14.6%), including dealing with patients and relatives relationships with colleagues and dealing with ward managers and supervisors and dealing with hospital administration (12%), including inadequate staff, overcrowded ward, and poor working environment. On the other hand, seeking support from friends and colleagues, using different cognitive strategies, and leisure activities were the most used coping strategies to deal with stress. In addition, results indicated that the stress level negatively correlated with the sickness level. Boyacı et al. (2014) used 27 questions from the literature to investigate the level of stress, influencing factors, and coping strategies among 103 physicians, nurses, health technicians, allied health personnel, and administrative services personnel. Results showed that inequitable distribution of tasks, work ignored by others, the widespread use of gossip in the workplace, fear of patient dissatisfaction and complaints, relations with management, and injustice in performance evaluation were the leading stress causes. In terms of coping strategies, the most reported were "I endure in silence and burn myself out", "I try to solve it on my own", and "I share it with my best friends or family and try to find a solution". In addition, results indicated that stress factors and coping strategies significantly varied with occupation, gender, and business of a lifetime. The authors recommended distributing the work fairly among the staff, provide adequate in-service training, provide a clear job description, involve employees in the decisions made, and provide regular training for workers to cope with stress. Unsal Atan et al. (2013) investigated the consequences of experienced violence among 441 nurses from different units in Turkey. 60.8% of the nurses agreed that they were victims of verbal and/or physical violence from staffs, patients, and visitors. In addition, results reported a negative relationship between violence and the health of nurses. Forms of negative impacts included pain, palpitations, stress, feeling worthless, and disappointment. Finchilescu et al. (2018) used a self-reported questionnaire to study the relationship between bullying at the workplace and mental well-being, job satisfaction, and propensity to leave among 102 nurses from a public hospital in Zimbabwe.

Results indicated that bullying had a significant impact on nurses' mental well-being and that higher levels of bullying were negatively associated with job satisfaction and positively associated with the propensity to leave.

Based on Boran et al. (2012), a total of 402 Jordanian participants (101 physician specialists, 52 general practitioners, 126 dentists, and 123 pharmacists) were interviewed to complete the General Health Questionnaire (GHQ-12) and a socio-demographic questionnaire and to answer other questions about job stress. Results showed that general practitioners reported the highest degree of stress, and physician specialists reported the lowest level of stress. Most frequently, symptoms were a headache, irritability, and consuming more energy drinks. Moreover, a high level of stress was significantly correlated with long working hours, being a woman, and the position or job title. The authors suggested that staffs must be trained to enable them to better cope with stress. Hamdan-Mansour et al. (2011) surveyed work-related stress among 92 mental health nurses, of which 72% were female, using the Mental Health Professionals Stress Scale (MHPSS), and they used the Social Support Scale (SSS) to investigate organisational support. The results showed that mental health nurses experienced a moderate level of stress and a low level of support from their supervisors and that nurses who perceived a low level of support from their supervisor were more likely to experience a higher level of work stress. A conflict with other health professionals and the lack of resources and relationships were the most frequent stressors reported in the study. The authors suggested that improving collaborative work conditions and providing appropriate support may reduce stress (. Hamaideh and Ammouri (2014) used the Nursing Stress Scale (NSS) to survey stress among 464 nurses from public and private hospitals. Results showed that nurses perceived more stress due to inadequate preparation, uncertainty concerning treatment, conflicts with physicians, conflicts with other nurses, and the lack of support. In addition, results indicated that nurses in public hospitals perceived higher stress than those in private hospitals. The authors recommended training staffs to enhance teamwork, communication, family interactions, and stress management. Masa'Deh et al. (2018) used an Arabic version of the Perceived Stress Scale 10-Items questionnaire (APSS10) to measure the stress level among 166 inpatients, outpatient, and addiction psychiatric nurses in Jordan of which 90.8% had a Bachelor's degree. Results showed that inpatient psychiatric nurses had the highest level of stress and that 60.12% of surveyed nurses reported aggression/violent behaviour from patients as the prime stressor. The used regression model indicated that the lack of resources, aggression/violent behaviour from patients, the lack of training, and long working hours were correlated with a high level of stress. The authors suggested scheduling shorter shifts and more attention to the needs of psychiatric nurses to improve the performance and the quality of patient care. Hasan and Tumah (2019) used the Devilliers, Carson and Leary (DCL) stress scale, the Psych Nurse Methods of Coping questionnaire, and the Beck Depression Inventory (BDI) to examine workplace stress, coping strategies, and psychiatric distress among 119 psychiatric nurses. Results showed that nurses experienced moderate levels of stress and psychiatric distress and that the highest stress scores were associated with dealing with physical and verbal abuse from patients or others, insufficient training to work with such patients, and dealing with potential suicide patients. On the other hand, the most used coping strategies were reminding self that the work will be appreciated and discussing work problems with colleagues. The authors suggested implementing training programmes to help psychiatric nurses manage occupational stress more effectively. Hamaideh et al. (2008) surveyed 464 nurses from 13 hospitals to investigate the stress level using the Nursing Stress Scale (NSS) and stressors and social supportive behaviours using the Inventory of Social Supportive behaviours (ISSB). The study accounted various factors, including gender, shift worked, education, model of nursing care provision (primary, team, functional, and unclear model), type of hospital (private, government or teaching), experience, and ward/unit's organisational structure (matrix, vertical, horizontal and unclear structure). The results showed that frequent stressors included death and dying (mean=16.13) and workload (mean=14.53). In addition, participants designated guidance as the most social supportive behaviour provided to stressed nurses. Moreover, results showed significant correlations between stressors, social supportive behaviours, level of education, shift worked, and model of nursing care provision, as well as between social supportive behaviours, units' decision-making style and commitment to work. The authors recommended that nursing administrators should intervene to decrease the level of stress among nurses and to provide different styles of social support to help nurses cope with stress.

Literature indicates that work-related stress gained a lot of attention worldwide. Published studies

revealed work-related stress levels, triggers and causes, consequences, and coping strategies used to reduce the effects of this epidemic. This study builds on findings from the literature and utilises pilot feedback from caregivers to construct a comprehensive survey of stress symptoms, coping strategies, and influencing factors or stressors among Jordanian healthcare givers.

2. Research methods

For the purposes of this study, a self-administrated questionnaire was developed based on published literature, pilot studies and suggestions of specialists. The questionnaire was used to survey healthcare givers at three major northern Jordanian hospitals with high patient flows. The target population included nurses, technicians, and physicians in the emergency departments (EDs), laboratories, intensive care units (ICUs), medical-surgical units, paediatrics, obstetrics, and gynaecology.

The questionnaire had four sections. The first section surveyed four demographics of respondents. Target demographics included gender, years of experience, work unit and position or title. Section two surveyed 18 physical, mental, and behavioural, symptoms caused by stress. Respondents were asked to determine how often they experienced each symptom during the past workweek on a scale range from "never" to "several times every day". Moreover, this section included a question about the effect of the symptoms on the ability to work and another question about whether the respondent was diagnosed for these symptoms, answering "yes" or "no". Section three consisted of nine coping behaviours commonly used to relieve stress. For each stress relief behaviour, the respondent was asked to select one of four responses: "no", "considering it", "sometimes", or "frequently". Finally, section four measures the degree of contribution of work stressors. The section uses a four-point scale ranging from "not at all" to "substantial" to indicate the impacts of various elements of the work environment or work stressors on the level of stress of the respondent. Work stressors are grouped into five domains: physical work environment (4 items), management (10 items), job demands (11 items), work relationships (5 items), and exchange with patients or accompanying person (4 items).

The questionnaire was distributed to healthcare givers, and 450 individuals responded, out of which 300 responses were used in the analysis. The statistical analysis of data was performed using the Statistical Package for the Social Sciences (SPSS) version 25. Cronbach, descriptive data analyses, such as frequencies, percentages, means and standard deviations, were used to describe the demographic characteristics of the respondents, the level of experienced symptoms and the level of the perceived stress. The overall scores of sections on symptoms and stressors were calculated by averaging related items. Moreover, the Analysis of Variance (ANOVA) and t-tests were used to examine the differences between the occurrence level of symptoms and the level of perceived stress according to respondents' demographics. Pearson's correlation analysis was used to gain an initial understanding of the relationship between the perceived level of stress and the anticipated outcomes (symptoms and behaviours). Multiple linear regressions were performed to determine the best predictors of the symptom frequency and recurrence. A value of $p < 0.05$ was considered statistically significant.

3. Research results

A total of 450 responses were collected and scanned thoroughly for clean-up; 300 responses were found complete and reliable. The remaining 150 responses were excluded either because the participant left a significant proportion of the survey empty, consistently marked the same response for all questions within a section, had frequent multiple responses to questions, or failed to report her/his demographics. The results obtained from the statistical analyses are shown in the Appendix tables. Table 1 summarises respondent demographics. Of the 300 participants (Table 1), 65.3% were females, 55% had five or fewer years of experience, and most of the respondents (58.7%) were nurses. Tables 2–9 showed the specific findings of the study.

To perform the above-mentioned analyses, responses were assigned a number proportional to the intended impact. E.g., responses regarding the frequency of experienced symptom (Table 2) were as follow: never (1), 1 to 2 times (2), 3 to 4 times (3), once a day or daily (4) and several times a day (5). Cronbach's alpha reliability coefficients for symptoms, coping behaviours, and stressors were 0.931, 0.793, and 0.945, respectively. Moreover, Cronbach's alpha reliability coefficient for the total scale was 0.958.

Table 2 shows descriptive statistics of symptom frequencies. The obtained results show that most of the respondents experienced a stress symptom at

Tab. 1. Characteristics of the surveyed participants (N=300)

Background variable		Number	Percent
Gender	Male	104	34.7%
	Female	196	65.3%
Experience	1–5	165	55.0%
	6–10	71	23.7%
	11–15	37	12.3%
	>15	27	09.0%
Unit	Emergency Department (ED)	42	14.0%
	Blood Laboratories	47	15.7%
	Paediatrics	48	16.0%
	Obstetrics and Gynaecology	57	19.0%
	Medical-Surgical units	64	21.3%
	Intensive Care Unit (ICU)	42	14.0%
Position	Nurse	176	58.7%
	Technician	45	15.0%
	Resident Doctor	36	12.0%
	Specialist Doctor	43	14.3%

Tab. 2. Descriptive statistics of symptoms frequencies

Symptom	Never	1 to 2 times	3 to 4 times	Once every day (daily)	Several times everyday	% [a]	Mean ± SD
Frequent headaches	50	74	73	58	45	34.3	2.913 ± 1.306
Increased heart rate	133	92	29	22	24	15.3	2.040 ± 1.248
Breathing difficulty	181	60	29	17	13	10.0	1.737 ± 1.119
Change in blood pressure	150	81	34	22	13	11.7	1.890 ± 2.093
Increased sweating	132	80	39	26	23	16.3	2.093 ± 1.266
Increased dryness of my mouth	101	84	53	31	31	20.7	2.357 ± 1.317
Change in eating patterns	71	64	64	46	55	33.7	2.833 ± 1.423
Change in sleep patterns	58	70	63	85	24	36.3	2.823 ± 1.259
Continual tiredness	29	97	72	59	43	34.0	2.967 ± 1.218
Poor concentration	34	101	78	46	41	29.0	2.863 ± 1.215
Became more anxious	51	112	75	36	26	20.6	2.580 ± 1.161
Became more emotional	75	81	64	42	38	26.7	2.623 ± 1.334
Difficulty to relax	64	87	56	44	49	31.0	2.757 ± 1.375
Feel worthless	184	44	23	25	24	16.3	1.870 ± 1.316
Feel scared	140	76	38	24	22	15.3	2.040 ± 1.256
Lost interest in everything	125	66	46	31	32	21.0	2.263 ± 1.371
Became more irritable, moody and over-reactive to what others say	87	84	50	37	42	26.3	2.543 ± 1.386
Became more negative, frustrated and believing there is no solution	132	70	38	31	29	20.0	2.183 ± 1.350

Note: % [a] the proportion of participants who reported the once everyday occurrence of symptoms or several times every day.

least once during the week preceding the survey. Moreover, close to a third of respondents experienced some of the symptoms at least once a day. Among the many daily experiences of symptoms, the most frequent were change in sleep patterns (mean=2.823; % experienced daily = 36.3%), frequent headaches (2.913; 34.3%), continual tiredness (2.967; 34%), change in eating patterns (2.833; 33.7%), difficulty to relax (2.757; 31%), and poor concentration (2.863; 29%). In addition, about 54.67% of the respondents self-diagnosed stress based on these symptoms, 2.33% were diagnosed with stress by a medical doctor, and 1.33% were diagnosed with stress by a psychiatrist. 70.4% of the 125 respondents who experienced one or more of these symptoms at least 3 to 4 times indicated that these symptoms had a moderate or high effect on their ability to work. Table 3 shows that the frequency of a symptom reoccurrence was significantly influenced by gender and years of experience. Female respondents and those with fewer years of work experience (i.e., 1 to 5) yielded the highest means among their respective groups.

Table 4 shows feedback on coping behaviours to relieve stress: taking un-prescribed medications (mean = 2.267; % using = 52%), smoking tobacco (1.980; 41.7%), and taking more leaves/vacations just to run off work" (1.960; 41.3%). On the other hand, less than 7% of participants start drinking alcohol

Tab. 3. Influence of demographics on the frequency of occurrence of reported symptoms

Background variable		Mean	SD	Test value	P-value
Gender	Male	2.236	0.822	**-2.600 (T)**	**0.010**
	Female	2.502	0.854		
Experience	1–5	2.549	0.821	**4.728 (F)**	**0.003**
	6–10	2.368	0.848		
	11–15	2.146	0.873		
	>15	2.027	0.840		
Unit	Emergency Department (ED)	2.475	0.927	1.874 (F)	0.099
	Blood Laboratories	2.122	0.803		
	Paediatrics	2.625	0.893		
	Obstetrics and Gynaecology	2.457	0.994		
	Medical-Surgical units	2.425	0.726		
	Intensive Care Unit (ICU)	2.333	0.708		
Position	Nurse	2.495	0.847	1.938 (F)	0.124
	Technician	2.193	0.852		
	Resident Doctor	2.424	0.829		
	Specialist Doctor	2.277	0.856		

Note: items in bold are significant at the 0.05 level.

Tab. 4. Coping behaviours mean and percentage values

Coping Behaviours	No	Considering it	Sometimes	Frequently	% [a]	Mean ± SD
Take prescribed medications	219	2	65	14	26.3	1.580 ± 0.979
Take un-prescribed medications	125	19	107	49	52.0	2.267 ± 1.166
Start smoking tobacco	169	6	87	38	41.7	1.980 ± 1.168
Start drinking alcohol	281	3	14	2	05.3	1.123 ± 0.492
Start smoking marijuana	283	2	10	5	05.0	1.123 ± 0.525
Take illegible drugs	276	4	15	5	06.7	1.163 ± 0.581
Consider about leaving work	231	6	35	28	21.0	1.557 ± 1.066
Take more leaves/vacations just to run off work	165	11	95	29	41.3	1.960 ± 1.121
Come late to work	216	6	63	15	26.0	1.590 ± 0.982

Note: % [a] the proportion of participants who reported the using of methods sometimes or frequently.

(1.123; 5.3%), start smoking marijuana (1.123; 5%) or take illegal drugs (1.163; 6.7%). The t-test and ANOVA analysis (Table 5) show that coping behaviours to relieve work-related stress is significantly influenced by gender ($p < 0.05$), where male participants scored higher than female. Potential reasons behind such limited behaviours on consuming illegal substances include religion, society, and legal consequences.

Table 6 shows descriptive statistics of the extent to which surveyed work stressors contribute to the level of stress experienced by respondents. Linguistic responses were quantified as: "not at all" (1), "slight" (2), "moderate" (3), and "substantial" (4). The results indicated that the stressor "job demands" had the highest effect on participants (mean=2.547) while "work relationships" had the lowest effect (1.930). All in all, 13 stressors had a computed stress level with a mean above 2.5 (the limit between ordinary (no or slight) effect and notable (moderate or high) effect). Moreover, computed percentages of notable effects show alarming percentages of individuals who reported "moderate" or "substantial" effects. This requires management action to resolve related problems and reduce impacts on caregivers. Table 7 shows the correlations between the respondent demographics and their perceptions of stressors. The findings demonstrate that the perceived level of stress is influenced by all demographics. The results show that combinations of being a female, having low experience (1 to 5 years), working in paediatrics or obstetrics and gynaecology and being a nurse yield the highest means among their respective groups.

Table 8 presents the Pearson correlations between the total means of stressors, symptoms, and coping behaviours. The results show medium to strong positive correlations with p less than 0.05 between stressors and the frequency of symptom strength. Moreover, results show medium positive correlations between stressors and coping behaviours. This suggests that the presence of work stressors notably increases levels of stress, increases the frequency of symptoms, and influences coping behaviours. The stepwise multiple regression analysis was performed to analyse the influence of work environment, management, job demands, work relationships, and exchange with patients or accompanying person on the recurrence of symptoms, the response variable. The model correlates the overall means of stressors with the overall mean of symptoms.

Table 9 shows the results of the final model of regression with ($F=41.53$, $p= 0.00$) and $R=0.60$. Results indicate that an increment of one unit in stress caused by job demands alone can predict an increase in the recurrence of symptoms by 33.4%. Moreover, an increment of one unit of job demands combined with one unit of work environment, one unit of management, or one unit of work relationships stressors predict about a 50% increase in the recurrence of symptoms.

Tab. 5. Influence of respondent demographics on reported coping behaviours

Background variable		Mean	SD	Test value	P-value
Gender	Male	1.715	0.624	**2.927 (T)**	**0.004**
	Female	1.529	0.459		
Experience	1–5	1.569	0.537	0.594 (F)	0.619
	6–10	1.634	0.503		
	11–15	1.667	0.498		
	>15	1.535	0.592		
Unit	Emergency Department (ED)	1.485	0.553	0.535 (F)	0.750
	Blood Laboratories	1.655	0.591		
	Paediatrics	1.599	0.422		
	Obstetrics and Gynaecology	1.589	0.528		
	Medical-Surgical units	1.602	0.552		
	Intensive Care Unit (ICU)	1.624	0.513		
Position	Nurse	1.604	0.538	0.692 (F)	0.558
	Technician	1.667	0.592		
	Resident Doctor	1.540	0.478		
	Specialist Doctor	1.522	0.456		

Note: items in bold are significant at the 0.05 level.

Tab. 6. Levels of stressors among healthcare givers

	Subscale/Items	Not at all	Slight	Moderate	Substantial	Mean ± SD	%[a]
WE	**Work Environment**					**2.275±0.735**	
WE1	Overcrowded work areas	44	106	78	72	2.593±1.009	50.00
WE2	Unclean facilities	89	107	64	40	2.183±1.007	34.67
WE3	Lack of equipment and resources	63	81	82	74	2.557±1.079	52.00
WE4	Lack of security of personal belongings	141	106	35	18	1.767±0.880	17.67
M	**Management**					**2.517±0.822**	
M1	Frequent change in management techniques	55	89	81	75	2.587±1.055	52.00
M2	Conflicting responsibilities/ multiple supervisors	56	95	73	76	2.563±1.062	49.67
M3	Too much supervision	71	87	87	55	2.420±1.043	47.33
M4	Over-harsh discipline	91	91	65	53	2.267±1.077	39.33
M5	Discrimination or prejudice from managers	41	74	100	85	2.763±1.012	61.67
M6	Lack of communication with management	69	84	77	70	2.493±1.086	49.00
M7	Failure to recognise achievements	42	83	75	100	2.777±1.060	58.33
M8	Lack of respect as an employee from managers	85	87	62	66	2.363±1.115	42.67
M9	Lack of emotional support after a serious adverse event from managers	62	89	81	68	2.517±1.058	49.67
M10	Lack of emotional support if I looked distressed during work from direct supervisor	81	75	82	62	2.417±1.096	48.00
JD	**Job Demands**					**2.547±0.755**	
JD1	Unclear job responsibilities	77	113	64	46	2.263±1.009	36.67
JD2	Conflicting work tasks	85	93	75	47	2.280±1.042	40.67
JD3	Unacceptable work tasks	79	90	60	71	2.410±1.116	43.67
JD4	Long working hours	33	77	78	112	2.897±1.031	63.33
JD5	Inflexible working hours	43	89	84	84	2.697±1.030	56.00
JD6	Not enough time to rest	40	62	94	104	2.873±1.036	66.00
JD7	Too much work	34	67	100	99	2.873±0.997	66.33
JD8	Repetitive work	36	96	82	86	2.723±1.008	56.00
JD9	Synchronous work	92	83	71	54	2.287±1.090	41.67
JD10	Working alone	105	88	58	49	2.170±1.082	35.67
JD11	Lack of physical safety	58	83	82	77	2.590±1.067	53.00
WR	**Work Relationships**					**1.930±0.807**	
WR1	Bullying, harassment or unwanted behaviour	163	87	30	20	1.687±0.904	16.67
WR2	Lack of respect from colleagues	144	92	38	26	1.817±0.962	21.33
WR3	Lack of communication between colleagues	99	111	57	33	2.080±0.978	30.00
WR4	Lack of emotional support after a serious adverse event from colleagues	103	109	61	27	2.040±0.953	29.33
WR5	Lack of emotional support if I looked distressed during work from colleagues	109	104	57	30	2.027±0.978	29.00
Ex	**Exchange with patients or an accompanying person**					**2.281±0.859**	
Ex1	My emotional sensitivity to patient's age, gender or illness	71	95	75	59	2.407±1.054	44.67
Ex2	Risk of violence, harassment or unwanted behaviour from patients or an accompanying person	109	102	48	41	2.070±1.034	29.67
Ex3	Lack of respect from patients or accompanied person	87	104	62	47	2.227±1.053	36.33
Ex4	Impatience of patients or an accompanying person	75	90	68	67	2.420±1.093	45.00

Note: %[a] the proportion of participants who rated the perceived level of stress moderate or substantial.

Tab. 7. Influence of demographics of participants on the level of perceived stress

Background variable		Mean	SD	Test value	P-value
Gender	Male	2.283	0.689	**-2.130 (T)**	**0.034**
	Female	2.502	0.854		
Experience	1-5	2.473	0.602	**3.658 (F)**	**0.013**
	6-10	2.363	0.612		
	11-15	2.242	0.696		
	>15	2.112	0.522		
Unit	Emergency Department (ED)	2.396	0.508	**2.715 (F)**	**0.020**
	Blood Laboratories	2.106	0.566		
	Paediatrics	2.500	0.502		
	Obstetrics and Gynaecology	2.496	0.701		
	Medical-Surgical units	2.407	0.682		
	Intensive Care Unit (ICU)	2.379	0.611		
Position	Nurse	2.491	0.585	**5.031(F)**	**0.002**
	Technician	2.151	0.561		
	Resident Doctor	2.361	0.692		
	Specialist Doctor	2.226	0.659		

Note: items in bold are significant at the 0.05 level.

Tab. 8. Bivariate correlation coefficients between the total mean of stressors, symptoms and coping behaviours

Variables	WE	M	JD	WR	Ex	Symptoms	Coping behaviours
WE	1	0.338	0.436	0.363	0.439	0.392	0.226
M		1	0.752	0.362	.369	0.490	0.289
JD			1	0.387	0.466	0.556	0.269
WR				1	0.512	0.361	0.352
Ex					1	0.378	0.369
Symptoms						1	0.340
Coping behaviours							1

Note: items in bold are significant at the 0.05 level. WE: Work Environment stressors; M: Management stressors; JD: Job Demands stressors; WR: Work Relationships stressors; Ex: Exchange with Patients or accompanying person stressors.

Tab. 9. Predictors accepted to be in the final model of the stepwise multiple regression regarding the influence of stressors on the recurrence of symptoms

Predictors	R	R^2	Adjusted R^2	Regression Coefficients (B)	P-value
JD	0.556	0.309	0.307	0.334	0.000
WE	0.580	0.337	0.332	0.153	0.004
WR	0.593	0.352	0.345	0.125	0.018
M	0.600	0.360	0.352	0.142	0.047

JD: Job Demands stressors; WE: Work Environment stressors; WR: Work Relationships stressors; M: Management stressors.

4. Discussion of the results

Unlike previous related studies, this study combined the results for various healthcare professions, work units, genders, and experience levels. Moreover, the study surveyed symptoms, coping behaviours, and workplace stressors.

While it is difficult to address generic resolutions to each stressor individually, healthcare organisations can consult specialists and literature for best practices and customise solutions based on their specific conditions, capabilities, and resources. E.g., local government or legal personnel may help structure regulations to govern aggressive interactions among healthcare givers and between caregivers and patients or their companions. Moreover, the findings may serve the Jordanian care providers in prioritising their efforts to improve the mental well-being of their staff. E.g., more focus should be given to resolving stress causes related to job demands, especially those that include combinations of long working hours, not enough time to rest, and too much work. A key to resolving such issues can be achieved through the hiring of sufficient numbers of staff based on foreseen demands of the individual units. In addition, job rotation, when feasible, may largely ease stress due to inflexible working hours and repetitive work.

Study results illustrate significant correlations between the perceived level of stress due to stressors and the anticipated outcomes; symptoms and coping behaviours. A notable percentage of Jordanian healthcare workers suffer repeated symptoms that indicate stress suffered in the work environment. To cope with their stress, some caregivers resort to unhealthy behaviours rather than consulting a specialist or practising healthy behaviours to relieve their stress. In addition to self-harm, foreseen consequences include high turnover among the medical staff and inferior performance of caregivers in terms of dedication and quality. To ease symptoms and to better control coping behaviours, HR managers can consult the literature and local psychiatrists for best practices in stress diagnosis and relief. From the literature, such relief efforts may include guidance, support groups, regular group and one-on-one meetings with psychiatrists, and leisure activities. The choice of coping mechanisms in addition to other work regulation must consider the gender influence because, in general, female caregivers show higher levels of stress recurrence and less tendency to use unlawful coping methods.

The obtained results are consistent with those presented in individual studies conducted worldwide. Next, some sample findings are offered from the surveyed literature that investigates adverse consequences of workplace stress, coping strategies, and the influencing stressors in healthcare. Boran et al. (2012) elaborated that frequent symptoms were headaches, irritability, and consuming more energy (e.g., caffeinated) drinks. Al-Zubair et al. (2015), Boran et al. (2012), and Lin et al. (2007) showed that stress could lead to illnesses, such as musculoskeletal fatigue, nervousness, headaches, and irritability. Suresh et al. (2013) discussed the relationships between high levels of stress and job dissatisfaction. Arimura et al. (2010) examined the relationship between work stress and the occurrence of medical errors. Williams et al. (2007) discussed turnover intention and absenteeism. Chen et al. (2014) and Williams et al. (2007) addressed reduced performance and low quality of care. Finchilescu et al. (2018) stated that higher levels of bullying were associated negatively with job satisfaction and positively with the propensity to leave. Moreover, researchers reported several stress-coping strategies used by caregivers. Gholamzadeh et al. (2011) indicated that the most common coping strategies used by nurses were self-control and positive reappraisal. Gleeson et al. (2019) demonstrated relationships between stress and the consumption of alcohol and antidepressants/anxiolytics. Boyacı et al. (2014) stated that the most reported coping strategies were "I endure in silence and burn myself out" and "I try to solve it on my own". Callaghan et al. (2000) showed that seeking support from friends and colleagues, using different cognitive strategies, and leisure activities were the most used coping strategies to deal with stress. Hamaideh et al. (2008) stated that guidance was the most frequent type of help provided to stressed nurses. Hasan and Tumah (2019) discussed that the most frequent coping strategies were reminding oneself that the work will be appreciated and discussing problems with colleagues. Furthermore, various researchers investigated workplace stressors in the healthcare environment. Setti and Argentero (2011) deliberated that long working hours, the lack of control over work, poor social support, technological advances, and the shortage of staff were responsible for the high levels of stress experienced by healthcare workers. Finchilescu et al. (2018) indicated that bullying had a significant impact on the mental well-being of nurses in Zimbabwe. Halpin et al. (2017) showed that workload, inadequate staffing, and managing multiple role

demands were the most reported stressors among newly qualified nurses in the UK. Gholamzadeh et al. (2011) showed that the major sources of stress among emergency department nurses in Shiraz were problems related to the physical environment, workload, dealing with angry patients or their relatives, being exposed to health and safety hazards, and the lack of support by nursing administrators. Based on Boyacı et al. (2014), results showed that inequitable distribution of tasks, work ignored by others, widespread gossip in the workplace, fear of patient dissatisfaction and complaints, relations with management, and injustice in performance evaluation were the leading stress causes among caregivers in Turkey. Callaghan et al. (2000) reported that nursing issues, such as too much work, dealing with emergencies, and job responsibilities were key factors to experiencing stress among nurses in Hong Kong. For the case of Jordan, Hamaideh et al. (2008) showed that death/dying and workload were the most frequent stressors among Jordanian nurses. In the paper by Hamaideh and Ammouri (2014), the authors showed that inadequate preparation, uncertainty concerning treatment, conflicts with physicians, conflicts with other nurses, and the lack of support were the most reported causes of stress among Jordanian nurses. Hasan and Tumah (2019) reported that dealing with physical and verbal abuse from patients was highly stressful. Boran et al. (2012) showed that high levels of stress were significantly correlated with long working hours, being a woman, and the position (job title). In addition to superiority issues associated with the job title within healthcare teams, researchers showed that a care unit was a possible cause of stress. Callaghan et al. (2000) stated that paediatric nurses reported the highest levels of stress. Masa'deh et al. (2018) showed that inpatient psychiatric nurses had the highest level of stress and that they faced aggressive behaviour from patients. Based on findings by Boran et al. (2012), general practitioners recorded the highest degree of stress.

Conclusions

In light of the present findings, a structured system is necessary within Jordanian healthcare organisations to detect and resolve causes of stress and to guide coping behaviours. It is of utmost importance that human resource managers in Jordanian healthcare organisations focus on improving various elements of the work environment. The obtained results can help decision-makers optimise and prioritise their resources to eliminate or significantly reduce stressors. Moreover, a structured plan is needed to broaden awareness among caregivers about the importance of professional diagnoses of stress and the use of lawful methods to relieve stress.

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Application of customisation and personalisation in digital solutions of the non-life insurance market: a case study of Lithuanian, Latvian and Estonian e-sales platforms

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ABSTRACT

The Baltic non-life insurance market has not only continued recording a dynamic premium growth in the past three years but also has shown a significant transition to digital technologies and solutions. Here, the development of customised insurance products and systems, assessment of claims, and creation of personalised customer experience can be considered best practices in the application of theoretical concepts and, accordingly, require continuous studies from a scientific point of view. Therefore, the following research aims to present an as-is status of existing solutions of digital insurance platforms in Baltic countries and to clarify their compatibility with customisation, personalisation, and value co-creation features at the practical product and functional levels. Accordingly, a case-study method following a combination of a descriptive embedded single-case design and the state-of-the-art method was applied in the analysis of the non-life insurance market, its e-channel environment, and platforms of three Baltic countries — Lithuania, Latvia, and Estonia. The multidimensional assessment matrix has been designed to present the results of the case study analysis on the practical product and functional levels. Research results refer to an assumption that ideas and methods of Mass Customisation and Mass Personalisation concepts, as well as their combination with digital solutions, penetrate the analysed part of the non-life insurance market in the Baltic countries and result in a mutually useful outcome for insurance companies and end-users. The paper contributes to further theoretical investigation of digitalisation and digital transformation of the non-life insurance market in the Baltic countries, as well as the development of practical knowledge in combined management and IT solutions application.

KEY WORDS

mass customisation, mass personalisation, digitalisation, co-creation, Baltic insurance market

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Introduction

The global insurance market, especially a part of non-life insurance, has shown remarkable growth in numbers of direct premiums written in the past three years and since 2008. E.g., the year 2018 was marked by a premium raise of 1.5% and bypassing a new benchmark of USD 5 trillion (Swiss Re Institute, 2019; Insurance Information Institute, 2019). This positive trend is expected to persist until 2021, and the emerging markets in the Asia-Pacific region should continue

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to rise and stay the main insurance drivers of the insurance market of the whole world within this decade (Swiss Re Institute, 2019). Baltic insurance markets have also shown a substantial development and a positive volume of gross written insurance premiums (GWP) in the last three years with a high record in 2018 in all region countries:

1. Lithuania led among the Baltic States and reached EUR 102.8 million of GWP;
2. Latvia reached EUR 78.8 million of GWP;
3. Estonia reached EUR 25.6 million of GWP (The Baltic Times, 2019).

An overall yearly increase in these markets was about 14% in the non-life and health insurance segments and was driven by following combined circumstances as dynamic price corrections in motor insurance lines, an active consolidation of market players lead by Vienna Insurance Group AG both at the local and regional level, refurbishing brand identity, the optimisation of the sales network, digitalisation and growth of Baltic economies (BTA Baltic Insurance Company AAS, 2018, 2019). On the other hand, insurance companies have been strongly affected by external factors, such as process automation, e-commerce, and customer behavioural changes in the financial sector; therefore, they gradually integrated online services and e-sales platforms into their business models and strategies (Küster et al., 2016). Furthermore, a digitalisation strategy and the development of specific online services in the financial sector are recognised as mutually beneficial. Additional features of quality and flexibility in services and products can be provided for end-users, and a new model of customer loyalty and e-satisfaction can be created via mass personalisation and customisation features instead of maintaining a narrow focus on price knowledge and expectation management within organisations (Küster et al., 2016). Otherwise, the high usability of e-services and its rapid increase has become a new standard of the banking service, but it still possesses a pre-stage in the insurance market. Here, a strong focus on digitisation and digitalisation at a strategic management level of insurance companies are well recognised but seem to be insufficiently aligned and, therefore, might have a negative impact by leaving best practices of co-creation, personalisation, and customisation, and a customer involvement aside. Accordingly, the following questions were investigated in this particular research:

1. What is a practical as-is status of applying digital solutions, customisation, and personalisation features in the Baltic non-life insurance market?
2. Which type of online customisation frameworks are applied in the Baltic non-life insurance e-sales platforms?
3. How a spread of digitalisation and online customisation frameworks influences behavioural patterns of insurance end-users?

The following research aims to investigate the practical widespread of digital non-life insurance platforms in the Baltic region and clarify their compatibility with modern and combined online customisation frameworks.

1. Literature review

An intensive and multidimensional digital transformation or transition is widespread in public and private sector organisations worldwide, including the insurance market. Furthermore, a proliferation of customised and personalised digital solutions together with the Internet of Things (IoT) and Big Data Analytics (BDA) have enabled new decision making in businesses in terms of Customer Relationship Management (CRM), marketing, and sales strategies (Dimitris et al., 2018; Anshari et al., 2019; Khanboubi et al., 2019; Chromčáková, Starzyczná, & Stoklasa, 2017). Moreover, aiming to adapt and integrate Big Data application and the information generated from BDA, social media, and IoT platforms, financial companies have exploited and continued to invest heavily into new technologies as well as designed new e-business models (Dimitris et al., 2018; Khanboubi et al., 2019; Lezgovko & Lastauskas, 2019). These models now mainly support a high personalisation and customisation of operations in sales and daily back-office service as well as in their optimisation. However, the prevailing scientific studies within the digital insurance field illustrate dynamic changes in research directions, periods, and different positions towards semantical interpretations. Here, key differences can be identified in the research period during the decades 2000–2010 and 2010–2020. In the first period, researchers mostly focused on the technological application by investigating the influence and widespread of digital innovations in primary insurance activities of product underwriting, sales operations, and legal domains. Key research domains during this period were: product differentiation and presentation through electronic (online) distribution channels; emerging technology application in insurance distribution channels; new electronic insurance distribution channels and online platforms influence on internal insurance sales agent

network and external end-user experience; legal regulation and protection of end-users in electronic insurance distribution channels, platforms, and online sales process; compatibility and transition from non-agile legacy data processing systems and infrastructure to new generations of digital technologies, systems, and infrastructure (Stoeckli et al., 2018; Bohnert et al., 2019; Raudeliūnienė & Račinskaja, 2014).

In the past decade, researchers mostly focused on more combined analysis of digital insurance outcomes at the operational and strategical level in insurance organisations and overall insurance networks. Key research areas were: the development and deployment of multi-channel or multi-access technical solutions and their integration to the omnichannel-based insurance business model; a change of organisational mindset in insurance organisations and overall cultural barriers for a digital transformation in the insurance industry; a transition to a platform-based interaction and systemic value creation; the development of new personalised, situation-based mass insurance products like insurance of cyber risks or sachet insurances (bite-sized insurances) products as pets or cyclist insurance; a focus on a new mass customer base, which is strongly influenced by a growing millennial and z cohort, shared economy principles, and demand-driven insurance needs; Usage-Based Insurance (UBI) and On-Demand Insurance (ODI) based on improvements in risk and capital management as well as underwriting of automatic algorithmic decision-making processes; ensuring personal data protection and full access to it as well as reducing a negative influence on an end-user from information asymmetry situations or extreme forms of dynamic pricing (Wiesböck et al., 2017; Bohnert et al., 2019; Łyskawa et al., 2019; Baumann, 2020; El Arif, 2020; Baranauskas and Raišienė, 2021). To be more specific, this particular research contributes to the following scientific studies of insurance digitalisation. Some researchers, like Wiesböck et al. (2017), Klapkiv et al. (2018), Zarina (2019), and Shubenko (2020), conducted case studies within boundaries of specific insurance value chain parts, i.e., strategical management, claims management, sales distribution, product digitisation, also limited by the origin country or region. Bohnert et al. (2019), Łyskawa et al. (2019), and El Arif (2020) selected a more comprehensive and holistic approach by evaluating digital agendas, their implementation, and development. Moreover, investments from organisations in digital insurance enablers and possibilities of online distribution in Europe were also analysed by the mentioned authors. The global relevance of the topic is confirmed by the research efforts of Nguyen (2019) and Niraula and Kautish (2019) on Vietnam and Nepal cases. Zolnowski and Warg (2017), Stoeckli et al. (2018), and Warg (2019) have contributed to the field by multidimensional investigations, which present the status of digital intermediaries, Insurtech and their influence on the insurance industry as well as the shift from standardisation and product-based business model. Another group of scientists, like Lyubov (2018), Kaigorodova et al. (2018), Albrecher et al. (2019), and Baumann (2020), focused on literature reviews and case studies by using a technological point of view and revealed key directions, challenges, and impact of digital technologies and data science application in insurance processes and services. A significant contribution was also made by Eling and Lehmann (2018), Mitrovic et al. (2019), and Weingarth et al. (2019), who conducted case studies of digital transformation frameworks, strategies, and process steps from both a holistic point of view in the insurance industry and a value chain, and an empirical evidence point of view.

In general, the increase of practical and academic attention to the sustainable development of new fully digital, bespoke, and customised products or services plays a key role in the modern versions of Mass Customisation and Mass Personalisation concepts and overall e-business strategies as well. (Medini et al., 2015; Hora et al., 2016; Dissanayake, 2019). Mass Customisation and Mass Personalisation as separate research domains in a business organisation of the manufacturing field have received considerable attention as they have been thoroughly reviewed in many contexts in the last three decades. During the last decade, these concepts have been shifting theoretical boundaries and orientation to the stand-alone version of the E-Mass Customisation and Personalisation concept (e-MCP), which focuses on combined management and IT method application, end-user experience (UX), and interface (UI) management, and the overall digitalisation domain (Anišić et al., 2013; Kanama, 2018; Zhang et al., 2019). Moreover, in organisational practice, a rapid orientation towards the customer-centric approach, external demand-driven supply, and value creation via online platforms or process automation tools undoubtedly influences the content and development of these two concepts (Hu, 2013; Walczak, 2014; Tiihonen & Felfernig, 2017). Historically, these practical outcomes also reflect a transformation of the late 2000s from the traditional version concept to the electronic Mass Customisation and Mass Personalisation concepts,

which were driven by customer demand (Baranauskas et al., 2020). During this period, the Mass Customisation concept became a more interdisciplinary research field by including features of process management, marketing, engineering, information technology, and other related scientific domains. In the recent decade, the rise of the combined electronic Mass Customisation and Personalisation (e-MCP) concepts has been identified, which is driven not only by customer demand but also by big data and big data analytics (Pollard et al., 2016; Xu et al., 2016; Zhang et al., 2019; Baranauskas et al., 2020).

2. Research methods

The following research of Lithuanian, Latvian, and Estonian digital non-life insurance platforms aims to present an as-is status of existing digital solutions and clarify their compatibility with customisation, personalisation, and value co-creation features at the practical product and functional levels. Accordingly, a case-study method (following a combination of a descriptive embedded single-case design) and the state-of-the-art method were applied to analyse the digital insurance spread in the selected region within a specific period and market segment. From the point of view of the research process, both methods were used independently with an unbiased application and from the point of view of research design, the research is qualitative.

The state-of-the-art method provides a comprehensive as-is status of digitalisation and online customisation frameworks that influence behavioural patterns of insurance end-users. Here, a multilevel analysis was made into practical data sources from overview reports of the Global Insurance Markets Trends made by the Organisation for Economic Co-operation and Development (OECD) for 2017 and 2018, as well as sources and tools of Google Trends and Google Keyword Planner for the period from 1 January 2017 to 1 January 2020. The practical as-is status of digital insurance trends and end-user behaviour was identified by applying Google Keyword Planner and Google Trends tools. The functionality of Google Keyword Planner is a part of a free Google Ads application, which is well-recognised keyword research and evaluation tool deployed in practice to build targeted digital marketing campaigns based on volumes and content of data searched digitally by web users (Google Ads, 2020; Google Ads Help, 2020). Nevertheless, Google Trends is also defined as a similar free online tool to present dynamics of a particular search term or phrase in the Google search engine for a selected period (Google Support, 2020b; WordStream, 2020). In general, both tools are related to search engine optimisation (SEO) via digital marketing methods, but they also have a significant difference in statistical data counting logic and possible later usability. The main difference here is that Google Trends focuses on providing relative search volume data compared to all search volumes in the Google search engine while the Google Keyword Planner tool only estimates detail specific keyword search volume data in an inserted date and location range (Google Support, 2020c). Accordingly, both tools in this research have been used in the form of statistical mapping of selected keywords. Moreover, the tools have been accepted as suitable and sufficient to visualise yearly dynamics and define customer behaviour trends in the context of the research subject.

3. Research results

3.1. State-of-the-art of the Baltic non-life insurance market and digital trends in 2017–2020

The advent of the 4th Industrial Revolution stands not only for new cyber-physical systems, practical convergence of artificial intelligence solutions, IoT, and cloud computing, but also for a new data-driven and combined business management models, network, and ecosystems (Hu, 2013; Ogrean, 2018; Orenga-Roglá & Chalmeta, 2019). In the case of the insurance market and organisations, past years mark a continuous adaptation of technological innovations, and the shifted orientation to user-driven product customisation and personalised service, indicators of customer satisfaction, and experience management via e-service and sales platforms. On the other hand, general concerns exist that insurance organisations have not yet reached the target maturity level, so they could fully and easily integrate new technological innovations and results of BDA into their daily processes, products, or service management systems. Moreover, additional obstacles are identified: insurance organisations still appear to remain at a transition stage in customisation and personalisation processes compared to, e.g., the banking industry. Besides, insurance organisations now focus more on the identification and definition of heterogeneous data sources, evaluate the need for a technological, legal,

and management base and competencies update, preparation for possible structural and process changes (Chen et al., 2015). The background of the insurance requires accurate knowledge and data-based decisions and conceptual models; therefore, a predominant feature of products or services is standardisation (Koutsomitropoulos & Kalou, 2017). Therefore, following the multidimensional assessment analysis of Lithuanian, Latvian, and Estonian non-life insurance, e-sales platforms not only present the status of customisation and personalisation in the context of digital solutions but also reveal a preparation of insurance organisations to work with a new approach to Customer Relationship Management, data analytics and technological innovations inclusion into daily operations.

In the case of the non-life insurance market in Lithuania, Latvia, and Estonia, combinations of customisation, personalisation, and digital solutions can also be defined as important prerequisites to attain an additional competitive advantage and a better cost optimisation level in the long term. On the other hand, practical implications in the insurance market illustrate an existence of a narrow and concentrated purpose to ensure a numerous variety of products and/or customisation options without proper access to information or proper assistance in the customisation process. In theory, this situation is known as Mass Confusion and stands for consequences where customers are overwhelmed with processes, products, or service data, which later leads to user dissatisfaction as well as a decrease in demand for customised products or services, customer loyalty and branding (Huffman & Kahn 1998; Piller et al., 2005; Trentin et al., 2013).

First, indicators from OECD annual reports of 2017 and 2018 are taken for evaluation of the Baltic non-life insurance market development. The main data are summarised in Table 1 as per below.

Statistical data provided in Table 1 confirms dynamic and positive development trends in all Baltic insurance market as it is influenced by intense competition in the segment of motor insurance and a strong regional consolidation and synergy actions performed by Vienna Insurance Group AG and Austrian-based insurance broker group GrECo (IIZI, 2019; BTA Baltic Insurance Company AAS, 2018, 2019). Besides, increased accessibility of service via digital self-service platforms has also impacted the Baltic market significantly. Overall, the year 2017 marked the largest increase in gross written insurance premiums in all three countries, while in 2018, only Estonia was identified to hold a positive yearly turnaround in premiums. Furthermore, one of the indirect reasons for this positive trend can be identified as a persistently low-interest-rate environment that had a notorious impact on to results of regional life insurance companies within the same period. To compare on a global scale, in real terms, gross premiums increased by 3.5% and had a positive turnaround in overall 27 out of 50 OECD report countries in 2018 (OECD, 2019). According to analysts, several main reasons influenced the high revenue numbers in the Baltics:

- successful implementation of an increase in tariffs in the segment of motor vehicle insurance;
- growth in the amount of motor vehicle short- and long-term insurance policies due to an increase in the sale of new vehicles;
- a favourable macro-economic environment.

Otherwise, trends in claims payments in 2017–2018 are different in the Baltic countries and correlate to global up-down tendencies. I.e., in the year 2018, an annual real growth rate of gross claims payments rose in 26 and fell in 20 countries from the OECD report.

Second, it also should be noticed that due to different online insurance penetration levels and behavioural patterns of digital users in the Baltic non-life insurance market, both multichannel and omnichannel strategies and tools are widespread and vitally used in their e-channel environments and platforms. Therefore, new e-business models in the insurance sector have a primary focus on sales support and, then, on customer integration and co-creation pro-

Tab. 1. Country-level evaluation of non-life insurance market indicators

Country / Year	The annual growth rate of direct gross premiums		Annual real growth rates of gross claims payments	
	2017	2018	2017	2018
Lithuania	16.6%	10.1%	29.8%	-0.9%
Latvia	20.0%	18.9%	7.9%	13.4%
Estonia	11.7%	12.4%	4.0%	17.4%

*OECD provides only a mid-year report for 2019; therefore, data for analyses were not included.
Source: elaborated by the author based on OECD reports of 2017 and 2018.

cesses (Dimitris et al., 2018). These trends reflect end-user behaviour and can be illustrated by predominant search keywords, which are presented in Table 2. Accordingly, the main criteria which were applied in term analyses are defined as follow:

1. A search volume index was more than 0 and reached a required minimum of 1000 searches to get 1 point in the index;
2. Interest by a geographical location is limited to one for each country: Lithuania, Latvia, and Estonia;
3. Data exploration is carried out by using a search term, not a search topic. This logic was followed because the topic includes all related search terms while a search term is specific and results only show a relative volume of the term (Google Support, 2020a);
4. Used search indicators: custom time range (1 January 2017 – 1 January 2020); all categories; web search.

It should be emphasised that short-tail keywords analysed in the context of the Baltic insurance market not only strongly deviate in a scope number when comparing each the countries but also illustrate a different digital branding situation. To specify, in the case of Lithuania, within the most popular search terms (by search volume), only one term has a relationship to a brand of a specific insurance company. Compared to the case of Latvia under the same evaluation conditions, brands of three companies can be found and based on extracted data; the highest-ranking was Swedbank, one of the leading banks in the Baltic region. However, the strongest relationship to brand representation was identified in the case of Estonia, where the six most popular search terms had a relationship to a specific insurance company, bank, or insurance broker company. According to the listed indicators, the following terms, by taking an equivalent of each term in Lithuanian, Latvian and Estonian languages, were checked using the Google Trends

Tab. 2. Evaluation of insurance search terms popularity in the Baltic countries (1 January 2017 – 1 January 2020)

Search Term	Indicators					
	Lithuania		Latvia		Estonia	
	Competition rate*	Avg. searches**	Competition rate*	Avg. searches**	Competition rate*	Avg. searches**
insurance	69	16,570.00	83	3,535.00	74	3,472.00
online insurance	77	11,060.00	-	-	71	89
insurance calculator	44	4,735.00	70	172	62	752
car/MTPL insurance	81	7,581.00	84	1,418.00	91	9,503.00
car insurance online	82	1,503.00	-	-	43	12

*Indexed value. It shows how competitive ad placement is for a specific keyword in the selected location, time, and Search Network targeting options. The level of competition is from 0 to 100.
**Per month. The average number of times people have searched for a keyword and its close variants based on the month range, location, and selected Search Network settings.

Source: elaborated by the author based on the use of keywords planning the functionality of Google AdWords tool.

Tab. 3. Search volume index of research keywords in the Google Keyword Planner tool

Research keywords	Country and search periods								
	Lithuania			Latvia			Estonia		
	2017	2018	2019	2017	2018	2019	2017	2018	2019
insurance	78.23	78.21	80.54	72.75	72.35	70.83	63.28	62.63	71.65
insurance calculator	35.19	33.33	26.27	18.32	16.12	17.17	17	21.11	17.34
car/MTPL insurance	61.85	57.98	54.38	40.60	34.40	32	59.60	57.77	47.17

Source: elaborated by the author based on using the keywords planning functionality of Google AdWords tool.

tool: insurance, insurance calculator, car/MTPL insurance. A selection of the listed terms was made by following the criterion that all three terms had a high-level recognition among web end-users from January 2017 to January 2020. A structured summary of search volumes for the selected terms is provided in Table 3.

The results in Table 3 indicate several trends of digital insurance solutions in all three Baltic countries. First, in Lithuania and Estonia, the last three years resulted in a steadily increased rate of end-user interest in web searches by using a stand-alone search keyword insurance: the search volume index grew by two points in Lithuania, while in Estonia, the search index grew significantly, by 8.47 points. Moreover, the term insurance was in the Top 3 of all insurance-related short- and long-tail keywords in all three countries within the analysed period. On the other hand, a combined general keyword insurance calculator, which by its meaning is the closest to customisation and online insurance, showed a relatively low search volume index and small average search numbers per month in cases of Latvia and Estonia. The short-tail keyword car/MTPL insurance is identified to experience remarkable decrease tendencies of interest in all three countries where Lithuania has -7.47 point of the index, Latvia has -8.6 points, and Estonia has -12.43 points. Several factors impact this trend. Firstly, insurance companies, insurance brokers, and banks have developed effective branding in Latvia and especially in Estonia. For instance, a strong re-orientation to digital branding campaigns was identified in the case of Latvia within the period 2017–2018, when based on numbers of average monthly searches, interest in Swedbank insurance (originally, Swedbank apdrošināšana) increased by 34.65%, from 592.50 to 906.66 per monthly search. The same digital marketing strategy was selected by one of the leading region insurance companies Baltic Insurance Company AAS (BTA), which during the same period showed a tremendous investment and efforts to attract end-users via e-channel and overall digital platforms. The increase resulted in a positive outcome of 42.28% on interest, from 399.16 to 690.83 per monthly search. Nevertheless, the Estonian situation in digital branding and marketing activities was different with the main active player Swedbank and the online insurance broker company IIZI Kindlustusmaakler AS, while the other five insurance companies had up-down tendencies of interest. It can be assumed that insurance companies tend to apply the strategy of increasing strong associations between insurance as such and a company's brand; instead, they diversified the focus on integrating terms of specific products or services to the insurance concept by triggering associations among a product or service, a brand, and insurance. Secondly, a rapid increase of interest from end-users on other online insurance products, such as travel, home insurance, CASCO, or health insurance, is also an influential factor. Here, specifics of a country have a leading role in understanding and connotations of insurance, and the listed factors confirm a heterogeneity of digital platforms and solutions in the Baltic region.

Overall, all three markets appear to have the potential for a higher penetration level of digital marketing due to the dominance and use of short-tail keywords, which mostly consist of two or three keywords. These search keywords typically have a high cost and competitive demand with a low probability of conversion. To compare, the standard model of Search Demand Curve and overall global practical trends in digital marketing confirmed that 70% of search traffic comes from long-tail keywords, which consist of four to six specific keywords and have high conversation rates (Kritzinger & Weideman 2013).

3.2. A case study of Lithuanian, Latvian, and Estonian e-sales platforms in non-life insurance

Coming back to e-sales platforms of the Baltic non-life insurance market, first, it should be noted that here they serve as a digital form of the business-to-consumer (B2C) strategy and specific e-commerce functionality. Furthermore, an existing set up of e-sales platforms illustrates a vital distribution infrastructure of multi-channel retailing and has an aim where stakeholders of insurance companies would complement the traditional insurance sales channel with the online channel (Sekulovska, 2012; Frazer & Stiehler, 2014). On the other hand, a variety of existing framework forms and application scopes create issues of distinguishing them as marketing-oriented, product-oriented, target audience-oriented, and/or technical-oriented frameworks. Moreover, a qualitative assessment on an application-level of customisation and personalisation is difficult (Koutsabasis et al., 2008). Therefore, a descriptive framework of a multidimensional functional and product-orientated assessment matrix has been designed. It also incorporates features of personalisation and customisation from the perspective of a customer path by avoiding technically orientated evaluation of platforms. This way, the operational

as-is status of the digital sales platforms is presented and analysed practically to use for future academic discussions and/or practical application. In detail, the multidimensional assessment matrix has two main layers:

- The theoretical layer of nine online customisation framework combinations, as per Table 4, consists of three sub-layers, where possible combinations of customisation, personalisation, and standardisation are defined (Table 4). As per Table 4, six combined framework versions can be identified next to three standard theoretical frameworks of alternative-based, attribute-based, and question-based online customisation. These combinations illustrate both a theoretical transition among three standard frameworks and practical tendencies on a partial application of different frameworks in organisations, which occurs due to a variety of products or services, complexity, and end-user needs. Possible six combined versions are composed by comparing levels of application of three key framework components: customisation, personalisation, and standardisation and by applying a modified Robinson (2008a, 2008b, 2015) conceptual modelling framework together with the logic of the c-tuple method (Baranauskas, 2020). It should be noted that the selection of the online customisation framework depends on numerous internal and external indicators, such as product or service specifics, including complexity and pricing, market specifics, access and management of user information, technical dimension and capabilities in organisation, legal base requirements and restrictions, retail, customer relationship or marketing strategy and model, cyber insurance, etc. (Kamis et al., 2004; 2008; Park & Yoo, 2018; Wang, 2019). Three standard online customisation frameworks, which were developed by Kamis et al. in 2004, defined the most common options in practice. The alternative-based framework is used for products or services with limited possibilities to be customised as well as to get personalised assistance in the process. Here, the final design of products or services is presented instantly, and one of the listed options must be selected. In the case of the attribute-based framework, a different logic of the customisation pro-

Tab. 4. Nine combinations of online customisation frameworks

Types&Features	Alternative-based (AL-B)	Attribute-based (AT-B)	Question-based (Q-B)
Alternative-based (AL-B): Customisation level — Low Personalisation level — Low Standardisation level — High	(AL-B)	(AL-B) + (AT-B)	(AL-B) + (Q-B)
Attribute-based (AT-B): Customisation level — High Personalisation level — Middle Standardisation level — Middle	(AT-B) + (AL-B)	(AT-B)	(AT-B) + (Q-B)
Question-based (Q-B): Customisation level — High Personalisation level — High Standardisation level — Low	(Q-B) + (AL-B)	(Q-B) + (AT-B)	(Q-B)

Source: elaborated by the author based on Kamis et al., 2004; Baranauskas, 2020.

Tab. 5. Sample table of evaluation matrix of e-sales platforms at a product and functional level

Country	Product	Features					
		Standardisation	Customisation		Personalisation		
			Insurance options	Additional insurance risks and/or attributes	Self-service system	Chat	Multilanguage
XXXXX	MTPL						
	Travel						
	Property						

cess is used, and a more active end-user role is expected. Here, personalisation features are still vague, free selection of standard attributes is offered in the design phase, but, in general, a customisation level is defined as high. The question-based framework is most oriented to customisation and personalisation with an end-user actively engaged from the beginning of the process to building a bespoke type of products or services. This way, the value co-creation in forms of enjoyment and perceived control is transferred to end-users to increase trust, brand loyalty, and willingness to buy in the future (Kamis et al., 2004; 2008).

- The practical layer, as per Table 5, consists of a theoretical layer application at two e-sales platform dimensions: country and product & functional. To ensure the objectivity and validity of results in the evaluation matrix, the analysis of theoretical frameworks of alternative-based, attribute-based, and question-based online customisation was conducted by comparing the same three categories of products and three innovative insurance features. These insurance product categories and features of innovative insurance were analysed within all e-sales platforms in three Baltic countries — Lithuania, Latvia, Estonia.

Following Table 5, it should be stated that the selection of different insurance options in this evaluation stands for a form of the AL-B framework and has a meaning of at least two pre-defined insurance offers for an end-user. A possibility to build a fully customised insurance product from scratch using a range of features or modify a provided offer by selections from an add-on list, e.g., selecting additional insurance coverages as well as attributes, such as payment instalment or payment option, present an AT-B framework. The standardisation feature was included because it was a core component of insurance products and services for a long time (Koutsomitropoulos & Kalou, 2017).

Moreover, here, this feature also has a meaning of strictly defined insurance product boundaries and can be illustrated by the Motor Third Party Liability (MTPL) product, which is compulsory by law in all three Baltic countries and has clear and standard components. The personalisation level was evaluated considering the following three innovative insurance features and functionalities identified in e-sales platforms: a self-service functionality with a possibility to create and manage the personal account, a live chat, and a multilanguage selection in the front-end. Furthermore, these three personalised insurance service outcomes illustrate a fundamental basis for the Q-B framework implementation. The selected product was made under the logic of being the most popular and recognisable online insurance product for private persons. The company selection is based on two criteria:

- it is a company, which operates on a full scope of insurance services as well as in legal liability of the insurance market of a selected country, has a clear branding, operations branches and processes;
- it is not an insurance broker, does not operate in a selected country as a web-based price aggregator or as a provider of white-label insurance solutions.

According to two above-defined criteria, the following companies per country and their websites were selected and analysed. In Estonia, nine companies were selected — Kindlustusselts BTA Baltic Insurance Company (www.bta.ee); ADB Compensa Vienna Insurance Group (www.compensa.ee); ERGO Insurance SE (www.ergo.ee); ADB Gjensidige Eesti filial (www.gjensidige.ee); If P&C Insurance AS (www.if.ee); PZU Kindlustus on Leedu kahjukindlustusseltsi AB Lietuvos draudimas Eesti filiaal (www.pzu.ee); Salva Kindlustus AS (www.salva.ee); Seesam Insurance AS (www.seesam.ee); Swedbank P&C Insurance AS (www.swedbank.ee). In Latvia, nine companies were selected as well — AAS BALTA (www.balta.lv); Baltijas Apdrošināšanas Nams AAS (www.ban.lv); Apdrošināšanas akciju sabiedrība BTA Baltic Insurance Company (www.bta.lv); ADB Compensa Vienna Insurance Group (www.compensa.lv); ERGO Insurance SE Latvijas filiale (www.ergo.lv); ADB Gjensidige Latvijas filiāle (www.gjensidige.lv); If P&C Insurance AS Latvijas filiāle (www.if.lv); Seesam Insurance AS Latvijas filiāle (www.seesam.lv); Swedbank P&C Insurance AS (www.swedbank.lv). In Lithuania, ten companies selected — Balcia Insurance SE Lietuvos Filialas (www.balcia.lt); AAS BTA Baltic Insurance Company filialas Lietuvoje (www.bta.lt); ADB Compensa Vienna Insurance Group (www.compensa.lt); ERGO Insurance SE Lietuvos filialas (www.ergo.lt); AAS „Gjensidige Baltic“ Lietuvos filialas (www.gjensidige.lt); If P&C Insurance AS filialas (www.if.lt); AB Lietuvos draudimas (www.ld.lt); Seesam Insurance AS Lietuvos filialas (www.seesam.lt); Swedbank P&C Insurance AS (www.swedbank.lt). Analysis of websites took approximately from 20 to 30 minutes each.

Based on the practical analysis (Table 6), overall, methods and tools of Mass Customisation and Mass Personalisation concepts, as well as their combination with standardisation, have a mutually useful outcome for insurance companies and end-users. It also significantly penetrates the analysed e-channel environment and sales platforms of the non-life insurance market in three Baltic countries — Lithuania, Latvia, and Estonia. Moreover, the following conclusions can be distinguished per country and region level: (AT-B) + (AL-B) combination of the online customisation framework is predominant in Estonia. In five cases of a property product, all of them had a possibility from the beginning of the purchasing process to select a specific insurance option or customise a product by considering additional insurance risks or attributes as different payment instalments. In the case of the travel product, the AT-B framework setup was identified in eight out of nine cases. The standardisation of the MTPL product was recognised in all analysed cases, and in three cases, the combined version with the AT-B framework was identified. This is an example of a standardisation legacy in the online insurance sales platform. It also can be defined as a specific feature in the Estonian market and end-users because a predominant model in Latvia and Lithuania is a combined version of the AT-B framework as it offers additional insurance risk or attributes, such as a driver or/and passengers accident insurance, assistance on the road, partial or full CASCO insurance, etc. A high level of personalisation is another key feature of Estonia. In seven out of nine cases, the availability of two out of three features of the personalised service was identified, and in six cases, all three main features of the personalised insurance service were identified. Otherwise, the existing application form of three selected innovative insurance features and functionalities cannot be linked to the Q-B framework implementation. The main reason is their focus on supporting the leading AT-B, (AT-B) + (AL-B) or (AL-B) + (AT-B) combination frameworks and not serving as a stand-alone customisation option in the online insurance sales path.

A variation among (AT-B) + (AL-B) and (AL-B) + (AT-B) frameworks was identified in Latvia. Here, in both travel and property product lines, there was a possibility to select a specific insurance option from the beginning of the purchasing process and add-ons later in the process in eight out of nine cases of the travel insurance and three out of nine cases in the property insurance. Personalisation of services is also a common and robust feature of the e-channel environment and insurance sales platforms in Latvia: in eight out of nine cases, the availability of two of three features of personalised service was identified. The combination (AT-B) + (AL-B) of the online customisation framework is predominant in Lithuania. In total, in six out of nine cases, additional insurance risks or attributes were available to choose next to the main product, and in at least three out of nine insurance organisations, the AT-B framework was predominant in travel and property insurance sales. This situation illustrates that in Lithuania, a transition from a combined version of standardisation with the AT-B framework to the combined (AT-B) + (AL-B) online customisation framework is ongoing. Moreo-

Tab. 6. Results of the analysis into Baltic non-life insurance e-sales platforms

Country	Product	Features					
			Customisation		Personalisation		
		Standardisation	Insurance options	Additional insurance risks and/ or attributes	Self-service system	Chat	Multilanguage
Lithuania	MTPL	8/9	0/9	7/9	6/9	2/9	3/9
	Travel	0/9	3/9	6/9			
	Property	0/9	4/9	6/9			
Latvia	MTPL	8/9	1/9	5/9	8/9	3/9	8/9
	Travel	0/9	8/9	9/9			
	Property	1/9	4/9	6/9			
Estonia	MTPL	9/9	0/9	3/9	8/9	7/9	7/9
	Travel	0/9	0/9	8/9			
	Property	0/9	5/9	8/9			

Source: elaborated by the author.
* Analysis was made at February – March, 2020

ver, the existence and vitality of a standardisation approach are confirmed by a low level of personalisation. Here, only in two out of nine cases, an availability for more than one of the basic features of the personalised service was identified. Another key feature in the Lithuanian case was the highest level of customisation in MTPL product sales: in seven out of nine cases, a possibility to customise a product by selecting an additional insurance risk or attributes was recognised.

4. Discussion of the results

Assessment components and results of both theoretical and practical analyses are combined in Fig. 1.

As per Fig. 1 above, and results of the analysis in section 3.2, it can be identified that in Lithuania and Estonia, the combined version (AT-B) + (AL-B) framework of e-sales platforms is predominant and the following assumptions about the level of customisation, personalisation, and standardisation can be made:

- the customisation level varies in a full scale from high to low penetration;
- the personalisation penetration level varies on the scale middle–low;
- the standardisation penetration level varies on the scale middle–high.

This version of the online customisation framework illustrates the situation of user-friendly interface solutions and flexibility in online systems with partly implemented personalisation solutions, but organisations or/and the market are still dealing with a transition from the standardisation approach.

In the case of Latvia, a transitional period is identified, therefore, both (AT-B) + (AL-B) and (AL-B) + (AT-B) frameworks are proportionally applied. Here, the following compositions of main online customisation framework components can be identified:

- in four cases, where the (AL-B) + (AT-B) framework was used, the customisation level varies in a full penetration scale from low to high, the personalisation — in half of the scale from low to middle, and the standardisation — from high to low;
- in five cases, where the (AT-B) + (AL-B) framework was used, the customisation level varies in a full penetration scale from high to low, the personalisation — in half of the scale from middle to low, and the standardisation — from middle to high.

It appears that insurance organisations or/and the insurance market in Latvia have a strong legacy of standardisation, but at the same time, a transition to a higher customisation, and the customer engagement level is recognised, which is created by providing both separate customisation features and personalised assistance in the process.

Conclusions

The results of the literature review confirm dynamic changes in the field of insurance digitalisation and digital solutions used for primary insurance activities and value chain. Personalised and customised operations in sales, marketing, and product underwriting domains became a key driver of mod-

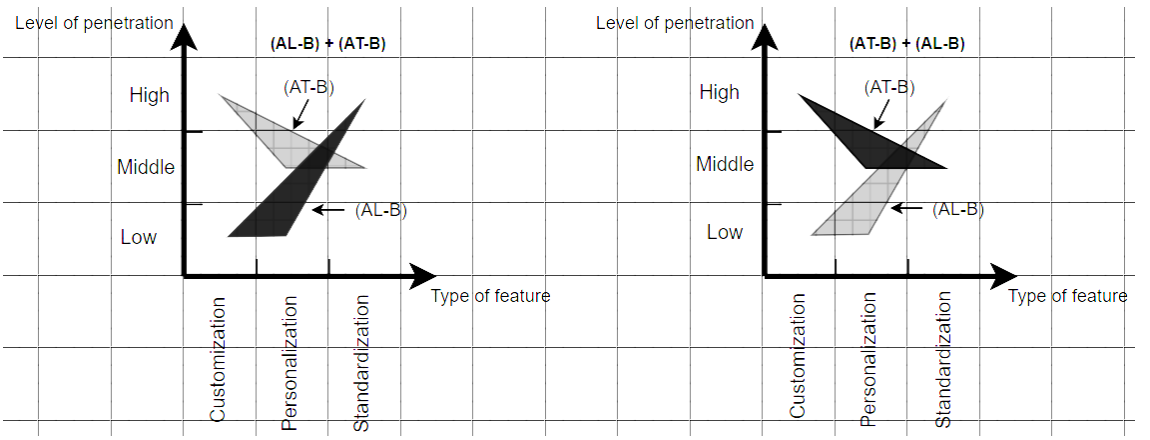

Fig. 1. (AL-B) + (AT-B) and (AL-B) + (AT-B) online customisation frameworks
Source: elaborated by the author based on Kamis et al., 2004; Baranauskas, 2020.

ern insurance studies. The recent theoretical studies in this field are focused on a multilevel and combined analysis of digital and customised insurance frameworks. This transition of theoretical attention to digital, sustainable, and customised insurance products, services, and e-platforms also illustrate the need for modern versions of Mass Customisation and Mass Personalisation concepts and their combined frameworks.

The practical analysis confirms a variety and a high level of customisation, personalisation, and their combinations in the non-life insurance e-sales platforms of three Baltic countries — Lithuania, Latvia, Estonia. It also illustrates that e-channel and combined digital solutions became a tactical tool in insurance sales and a significant part of the integrated marketing communication strategy (IMC).

The analysis revealed a well-designed, simple co-design process and the availability of tailored experience, which is mostly recognised in Estonia, while the weakest widespread was found in Lithuania.

Overall, the state-of-the-art confirms not only the perceived additional benefits of a product and Mass Customisation experience for end-users but also progress and penetration of e-commerce into the insurance industry, which for a long time has featured slow progress in launching these solutions.

Variations between (AT-B) + (AL-B) and (AL-B) + (AT-B) online customisation frameworks have been identified in cases of all three Baltic countries: in Estonia and Lithuania, the (AT-B) + (AL-B) framework is used, while in Latvia both combinations of (AT-B) + (AL-B) and (AL-B) + (AT-B) are applied. The application of combined frameworks has both advantages and risks looking from the perspective of future development.

Firstly, by evaluating the main advantages and open possibilities for further development, it is important to outline that existing frameworks allow the integration of new interface solutions with gamification and playfulness elements.

Therefore, an increase of a positive end-user attitude to insurance products, higher emotional brand attachment, and loyalty as well as involvement of the new target audience can be expected. On the other hand, if end users have low computer playfulness intentions and/or high computer anxiety, it will require offering interface solutions where predominant elements would come from the AL-B framework or at least a high level of personalisation integration into versions of AT-B frameworks.

Considering the end-user behavioural patterns, the following trends were identified in the Baltic region:

- the usability and popularity of short-tail keywords, which consist of two or three search keywords;
- a strong influence of a brand and an intensive re-orientation to digital branding promotion in the period 2018–2019 in cases of Estonia and Latvia;
- a rapid increase in online interest in non-motor products, such as travel, property (home) insurance, and health insurance, was recognised in the past three years.

Furthermore, to compare the results of the analysed region to a global scale and an overall development of the insurance business in the long term, it should be noted that digitally customised and personalised solutions seem to undertake a subordinate part in market growth. Moreover, the development of the above-defined frameworks in the insurance e-channel influences changes in sales and back-office processes increases the role of end-users, brings new product innovations and overall technologies along with the insurance specific-value chain, but has rather low expectations for any significant change in premium growth.

The conducted analysis contributes to the theoretical research field by revealing key outcomes of modern online insurance frameworks at different practical levels within Baltic non-life insurance organisations as well as indicates the influence on end-users of insurance platforms. It may also contribute as a foundation to future practical and theoretical research. Overall, the results of the analysis confirm the vitality of the Mass Customisation concept and application possibilities for the non-tangible and non-manufacturing-based practical field. Therefore, future researchers of digital financial product development, online sales, and marketing operations should take the influence of combined online customisation frameworks into consideration. Looking from the digital insurance perspective, further investigations might focus on the urge to evaluate a success rate in insurance sales where customised and personalised online framework solutions were applied. An additional research gap is identified in limited empirical investigations of modern online customisation frameworks widespread within the different profiles of end-users and overall at the insurance product level.

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Factors influencing behavioural intention to use MOOCs

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ABSTRACT

This analysis aimed to investigate the factors influencing the behavioural intention to use Massive Open Online Courses (MOOCs) in Thailand and Pakistan. The study was geared towards exploring the MOOCs, a relatively new technology platform allowing the spread of education and learning in various areas and fields and surpassing traditional online courses. The study adopted the UTAUT model with additional two variables of perceived autonomy and absorptive capacity. A quantitative method was applied using primary data collected from a sample of 490 and 513 respondents from Thailand and Pakistan, respectively. The sample size was composed of students in institutions of higher learning who were aware of MOOCs or intended to use them in their studies. The analysis was conducted using the Confirmatory Factor Analysis (CFA) and multi-group structural equation modelling (SEM). The study found that four variables (social influence, absorptive capacity, facilitating conditions and perceived autonomy) significantly influence the student intention to use MOOCs in Thailand and Pakistan. However, two variables (performance expectancy and effort expectancy) did not influence the student intention to use MOOCs in Thailand and Pakistan. The results indicated that the findings between the two countries were invariant. This study extended the model by Venkatesh et al. (2003), including two additional variables, the perceived autonomy and absorptive capacity. The study indicated various aspects related to the response of students using MOOCs. This study is especially beneficial during the COVID-19 pandemic for determining factors that officials of higher institutions of learning should consider when implementing MOOCs and associated online learning programs to deliver quality education to students.

KEY WORDS

technology management, Massive Open Online Courses (MOOCs), Multi-Group SEM, UTAUT, perceived autonomy, absorptive capacity

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Introduction

Massive Open Online Courses (MOOCs) represent a disruptive educational trend, particularly in higher education and lifelong learning (McGuire, 2014). These new technology platforms allow the spread of education and learning in various areas and fields and surpass traditional online courses. xMOOCs is used as a more conventional approach by such platforms as Coursera, Udacity, edX, or Miríadax, and some others use the connective pedagogy approach of

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cMOOCs (Kay et al., 2013). As a result, an increasing number of institutions of higher learning are adopting the MOOCs technology, and more educators are embracing the aspect of offering courses online using MOOCs. The increasing interest in MOOCs and associated enhancement through technology increases the opportunities for the exploration of more online pedagogies and business models within the education system. However, Seeman, Drake and Maysami (2013) argued that although MOOCs offer an advanced method of learning, designing and establishing it from scratch is associated with various issues, such as logistical, technological, financial, and pedagogical, which must be faced by the educators. For instance, concerning the matter of designing and running MOOCs, institutions and educators should be aware that MOOCs are quite demanding, hence require careful planning and feasibility of the course, as well as the availability of resources, such as finance and human skills. MOOCs typically require a substantive amount of time to run a single course for the first time, as well as additional hours per week to upkeep and update the trail while running it (Drake, O'Hara & Seeman, 2015). The study also indicated that the learners using MOOCs find it challenging to find a balance between their daily duties and their MOOCs courses and diverting enough time to MOOCs from their regular responsibilities or research and traditional teaching. Therefore, the overall performance of a course on MOOCs could depend on the duration and subject of the course, as well as the materials used by the instructors. According to the survey conducted by Adamopoulos (2013), MOOCs educators should keep in mind the relationship between logistical issues and design decisions to deliver successfully. Concerning the technological issues, the institutions and educators should be aware of the supporting systems used to run MOOCs. The most common aspect being applied nowadays by educators is to centralise access to learning content and materials (Ejdys, 2021).

Though MOOCs are a promising advancement in technology, several aspects may have issues. For instance, the adoption of MOOCs within the education system is the exclusion of traditional learning elements. According to MOOCs critique, the technology provides a "disruptive competition" to the status quo by eliminating some traditional learning elements, such as physical enrolment, physical class attendance, and evaluation elements (Flavin, 2017; Welsh & Dragusin, 2013). There is also a lack of expertise and training required in using MOOCs. MOOCs need tutors and teachers to be well versed with technology and computer operations to prepare lectures and tutorials, which involves video recording in some cases. Several studies have been conducted to investigate the aspects of MOOCs; however, there is no evidence of research comparing the MOOCs adoption in two different countries. This study addresses the gap by investigating the factors that influence the use of MOOCs in Thailand and Pakistan by conducting a multi-group analysis.

The study aims to investigate the factors that influence the Behavioural intention to use MOOCs in Pakistan and Thailand by conducting a multi-group analysis that compares the results of the two countries:

- What is the effect of Performance Expectancy (PE) on the Behavioural Intention to use MOOCs (BI) in Thailand and Pakistan?
- What is the effect of Effort Expectancy (EE) on the Behavioural Intention to use MOOCs (BI) in Thailand and Pakistan?
- What is the effect of Social Influence (SI) on the Behavioural Intention to use MOOCs (BI) in Thailand and Pakistan?
- What is the effect of Facilitating Conditions (FCS) on the Behavioural Intention to use MOOCs (BI) in Thailand and Pakistan?
- What is the effect of Absorptive Capacity (AC) on the Behavioural Intention to use MOOCs (BI) in Thailand and Pakistan?
- What is the effect of Perceived Autonomy (PA) on the Behavioural Intention to use MOOCs (BI) in Thailand and Pakistan?
- Is there a difference in the effects of the independent variables (PE, EE, SI, FCS, AC, & PA) on BI between the two countries?

This article is organised into several sections. The "Literature review" consists of a critical review of the past research conducted in the studied area. The "Research methods" section describes the techniques applied in the analysis of the study. The "Research results" section provides the findings of the analysis. The "Discussion of the results" section discusses the findings in reference to the previous studies, while the "Conclusions" summarises the article.

1. Literature review

MOOCs have brought education, knowledge, and skills from the top universities across the world to the least privileged scholars in emerging countries. MOOCs can be used by the most skilled professors and experts to share their expertise and knowledge

with learners despite the lack of time and geographical hindrances and at a low or no cost. Inferring from Hew and Cheung (2014), MOOCs have brought the revolution to education, particularly higher education in developing countries, where higher education or university attendance is a privilege. An excellent example of how MOOCs had impacted the education system in developing countries is edX, which is a non-profit platform developed by Harvard University. The platform boasts having approx. 15% of the registered students from developing countries. For instance, India alone has more than 300 000 registered students on edX.

Similarly, MOOCs have been established in various developing countries, both as individual for-profit platforms and others in collaboration with the national government or education ministry. Some countries that have embraced the technology, including Thailand, China, Israel, India, and Pakistan, among others, have witnessed significant improvements in the education sector. In addition to supporting higher education in developing countries, MOOCs are an effective way of reducing the level of illiteracy in those regions.

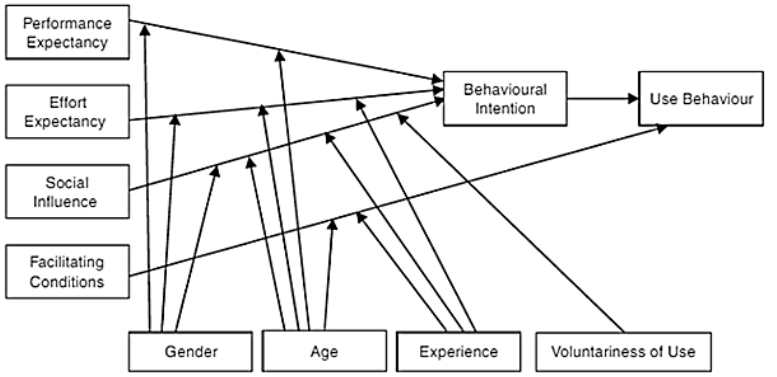
MOOCs were first recognised after launching some free online courses to the public in 2011. These courses received massive enrolment, more than 100 000 each. Since then, more than a thousand universities around the world have adopted MOOCs. By the end of 2018, there were more than 100 million students already enrolled in different MOOCs courses around the world (Shah, 2019). Many global MOOCs platforms have been established, such as Coursera, edX, and FutureLearn, while some MOOCs platforms were launched by governments that partnered with universities. Considering the motivation from the learners' perspective, the participation of students in MOOCs is of great interest to the higher education stakeholders. The factors influencing students to use MOOCs include learning flexibility, economic benefit, personal and professional identity, challenge, and achievement, as well as learning as fun. According to a survey conducted by Duke University researchers, four significant categories motivate students to choose MOOCs (Belanger & Thornton, 2013), including exploring and experiencing online education, convenience achieved by eliminating barriers encountered in the traditional educational system, supporting lifelong learning and acquiring knowledge and understanding of the topic concept, as well as fun and entertainment through intellectual stimulation.

According to Blackmon and Major (2017), MOOCs are coming as a revolution to developing countries. Developing countries usually face a lack of university entry spaces, while at the same time, there are significant barriers to entry. Therefore, MOOCs in developing nations present a comprehensive opportunity for exploration, as well as an extension of education to those who lack the opportunity to join higher education. Higher institutions of learning primarily focus on the learners' development of strong competencies, service-oriented mindset, principle and productive citizen (Stuss, Szczepańska-Woszczyna & Makieła, 2019). MOOCs have tangible career benefits to learners. Instead of experiencing some vague improvement in their career prospects, research has indicated that approximately 33% of the people who have undertaken MOOCs in developing countries have experienced more career benefits. These tangible benefits include finding a new job, starting a business, or receiving a pay rise or promotion. The learners who join MOOCs with the main objective of advancing their career have been reported to experience the most outcome.

Both Pakistan and Thailand have adopted the MOOCs technology in their education system. Considering that they are developing countries, the system is not fully integrated but have proved beneficial, especially to institutions of higher learning (Cinque, 2017). Thailand has one MOOCs, which was launched in 2017. The official platform is known as ThaiMOOC. In Pakistan, the adoption of MOOCs within the higher education system has not been fully integrated. Allama Iqbal Open University and the Virtual University of Pakistan utilise MOOCs and blended learning pedagogies. Although most universities in Pakistan offer distance learning, these programmes need to be aligned with quality-based MOOCs.

The Unified Theory of Acceptance and Use of Technology (UTAUT) model is graphically illustrated in Fig. 1 below and has four major constructs determining the behavioural intention and the ultimate behaviour of technological system adoption and use. These constructs include performance expectancy, effort expectancy, social influence, and facilitating conditions. In turn, these constructs are moderated by other factors, such as age, gender, experience, and voluntariness of use (Venkatesh et al., 2003). The model postulates that through an examination of these constructs, it can determine the key factors that influence technology acceptance in any given context.

Various studies have been conducted using the UTAUT model. Fianu, Blewett, Ampong and Ofori (2018) investigated the factors that influence the use of MOOCs by students. The study was due to the



Source: Venkatesh *et al.* (2003)

Fig. 1. Unified Theory of Acceptance and Use of Technology (UTAUT) model

widespread criticism regarding the rates of participation and enrolment in MOOCs. The study also found that the use of MOOCs is influenced by facilitating conditions, MOOCs use intention, and instructional quality. However, the constructs of effort expectancy and social influence do not influence MOOCs use intention. The study highlighted the importance of institutions having the necessary structures and resources to support MOOCs. Mendoza, Jung and Kobayashi (2017) carried out an empirical review of the studies on MOOCs adoption using the UTAUT model.

The study indicated a significant issue that has not been addressed by the literature. According to study findings, the most significant factors that influence the use of MOOCs was the performance expectancy. Facilitating conditions were identified as the major barrier to the intention to use MOOCs. The study also advised the use of other constructs, such as learners' variables and language competencies. Alaeddin, Altounjy, Zainudin and Kamarudin (2018) investigated consumer behaviour of switching to a mobile wallet using the TAM model incorporating an additional moderating variable of perceived risk. The study was motivated by the growing use of a mobile digital wallet, which facilitated online transactions using mobile phones.

The results of the study indicated that the perceived usefulness and the perceived ease of use had a significantly positive effect on the customer attitude to switch to mobile wallets. Also, they found a significantly positive relationship of the perceived risk as a moderating role between the attitude and the behavioural intention to switch to the mobile wallet technology. Liu, Miguel Cruz, Rios Rincon, Buttar, Ranson and Goertzen (2015) carried out a study to investigate the factors that determine the therapist's acceptance of new technology for rehabilitation using the UTAUT model. The study found that the performance expectancy was the strongest determinant of behavioural intention to use new technology in rehabilitation, while effort expectancy and social influence did not determine the behavioural intention. The results also indicated that the current use of technologies in rehabilitation was influenced by behavioural intention and facilitating conditions.

The conceptual framework was developed from a comprehensive and critical review of the literature. The conceptual framework comprises eight variables, namely Behavioural Intention to Use MOOCs (BI), Perceived Autonomy (PI), Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), Facilitating Condition (FC), Absorptive Capacity (AC), Perceived Autonomy (PA), and Culture (CL). Among these variables, the independent variables were PE, EE, SI, FC, AC, and PA. The dependent variable was BI, and the moderating variable was CL. The conceptual framework is given in Fig. 2.

Based on the above framework, the following eight hypotheses were developed and illustrated in Fig. 2.

H1: Performance Expectancy (PE) has a significant effect on the Behavioural Intention to use MOOCs (BI) in Thailand and Pakistan.

H2: Effort Expectancy (EE) has a significant effect on the Behavioural Intention to use MOOCs (BI) in Thailand and Pakistan.

H3: Social Influence (SI) has a significant effect on the Behavioural Intention to use MOOCs (BI) in Thailand and Pakistan.

H4: Facilitating Conditions (FCS) has a significant effect on the Behavioural Intention to use MOOCs (BI) in Thailand and Pakistan.

H5: Absorptive Capacity (AC) has a significant effect on the Behavioural Intention to use MOOCs (BI) in Thailand and Pakistan.

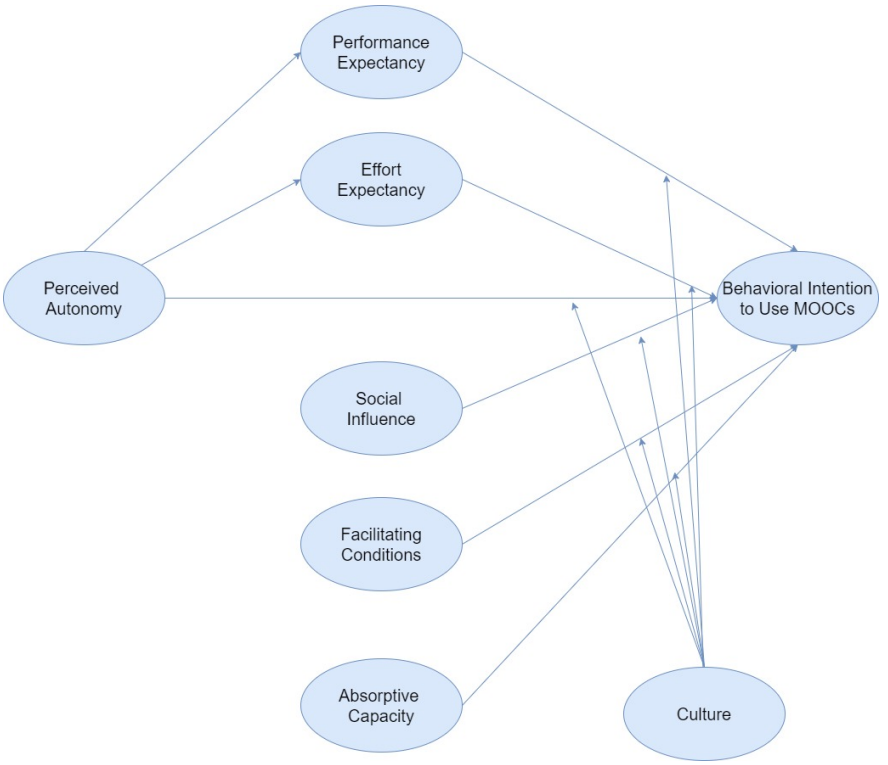


Fig. 2. Proposed conceptual framework

H6: Perceived Autonomy (PA) has a significant effect on the Behavioural Intention to use MOOCs (BI) in Thailand and Pakistan.

H7: There is a difference in the effects of the independent variables (PE, EE, SI, FCS, AC, & PA) on BI between the two countries.

2. Research methods

This research integrated two variables of the UTAUT model, i.e., perceived autonomy and absorptive capacity, to carry out an empirical study of the student intention to use MOOCs in Thailand and Pakistan. Specifically, the study aimed to investigate the factors affecting the student intention to use MOOCs in Thailand and Pakistan. The research population was students and professionals in Thailand and Pakistan who intended to use MOOCs for studying different courses. It also included MOOCs teachers and lecturers giving courses through MOOCs platforms. The sample comprised students and professionals familiar with the use of MOOCs in the two countries.

The mixed-method (qualitative and quantitative) was adopted for the study. With regard to quantitative research, the primary data was collected using questionnaires from a sample of 490 and 513 respondents from Thailand and Pakistan, respectively. The sample size was set following Hair et al. (2011), stating that the most acceptable way of determination is the 20:1 ratio (20 samples for one variable). Therefore, since the study has 20 observed variables, the appropriate sample size was 400 (20*20 observed variables). The study collected the required datasets in excess of the required responses of 400 from each country using stratified random sampling. The data was collected using a structured questionnaire, which was divided into two major sections. The first section focused on demographics that captured demographic characteristics of the respondents (age, gender, marital status etc.), and the second section collected data on the study variables. It used 5-point Likert Scale, where 1=strongly disagree, 2=disagree, 3= neutral, 4=agree, 5=strongly agree. The structural equation model (SEM) was applied to analyse the data. The statistical tests conducted were CFA to evaluate the model suitability, reliability analysis, and SEM for both countries and multi-group SEM analysis.

3. Research results

The descriptive statistics showed that more males in Pakistan (71.5%) intended to use MOOCs than in

Thailand (41.0%), and vice-versa in the case of women for Pakistan (28.5%) and Thailand (59.0%). Considering the age variable for both countries, the highest age category was 21–30 years, amounting to 67.6% for Pakistan and 71.8% for Thailand. For both countries, the second biggest age category was 18–20 years, represented by 18.9% in Pakistan and 20.8% in Thailand. However, Thailand had no respondents older than 60. Most of the respondents from both countries earned less or THB 10 000, representing 66.5% in Pakistan and 56.7% in Thailand. The second-largest category was respondents earning THB10 000–20 000, amounting to 17.3% in Pakistan and 24.9% in Thailand. Most of the respondents from Pakistan had good computer knowledge (40.5%), while most of the respondents from Thailand (9.6%) indicated having moderate computer knowledge. For Internet knowledge, most of the respondents from Pakistan (46.8%) indicated having good Internet knowledge, while most of the respondents from Thailand (44.1%) indicated having moderate Internet knowledge.

The model fitness was evaluated using the Confirmatory Factor Analysis (CFA) for the seven latent variables used in the study. For the case of Thailand, the base model proved to have a fit for the data. The chi-square statistic for the model was significant ($\chi2$ [114] = 354.916, $p < 0.01$), while the more practical alternative, the $\chi2$/df ratio = 3.113 was below five and was influenced by the sample size (Schumacker, Lomax & Schumacker, 2015; Hu & Bentler, 1999). The CFI was 0.971; TLI was 0.956; NFI was 0.957; which provided an excellent fit since the values were greater than 0.9 or close to 1.0. Additionally, the RMSEA was 0.063 (below the threshold of 0.80) (Browne & Cudeck, 1992; Schumacker, Lomax, & Schumacker, 2015). For the case of Pakistan, the chi-square statistic for the model was significant ($\chi2$ [114] = 458.643, $p < 0.01$), while the more practical alternative, the $\chi2$/df ratio = 4.023 was below five and was influenced by the sample size (Schumacker, Lomax & Schumacker, 2015; Hu & Bentler, 1999). The CFI was 0.96; TLI was 0.947; NFI was 0.948; which provided an excellent fit since the values were greater than 0.9 or close to 1.0. Additionally, the RMSEA was 0.077 (below the threshold of 0.80) (Browne & Cudeck, 1992; Schumacker, Lomax & Schumacker, 2015). The results of the CFA for both Thailand and Pakistan data indicated that it was feasible to move on and conduct the multigroup analysis.

3.1. Structural Equation Modelling (SEM)

After establishing the fitness of the model, the structural equation model was developed for both Thailand and Pakistan. The results are presented in the following subsections.

3.2. SEM analysis for Thailand

Fig. 3 below presents the SEM analysis model for Thailand and regression weights presented in the model.

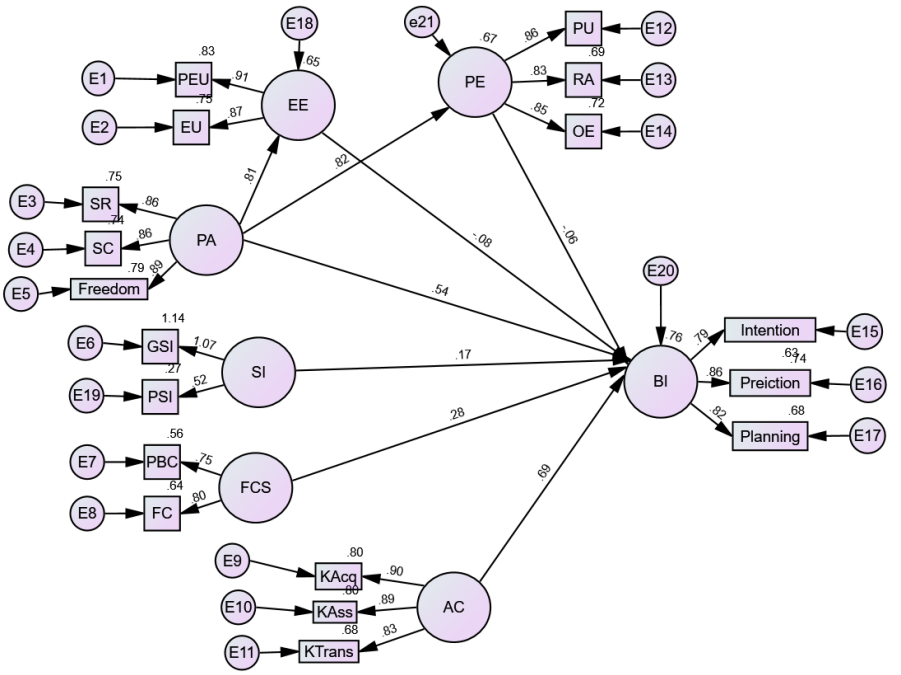


Fig. 3. SEM analysis model results for Thailand

Tab. 1. Path Analysis Regression weights for Thailand

PATHS	ESTIMATE	S.E.	C.R.	P-VALUE
PE ← PA	.705	.037	19.022	***
EE ← PA	.821	.045	18.396	***
BI ← PA	.359	.064	5.589	***
BI ← FCS	.196	.030	6.448	***
BI ← EE	-.051	.043	-1.178	0.239
BI ← PE	-.048	.054	-.896	0.370
BI ← AC	.478	.031	15.365	***
BI ← SI	.155	.029	5.277	***
BI ← EE ←PA	-0.042	-0.133	0.042	0.405
BI ← PE ←PA	-0.034	-0.131	0.055	0.511

Note: *** significant at 0.01; ** significant at 0.05; BI = Behavioural intention to use; PE = Performance Expectancy; EE = Effort expectancy; PA = Perceived Autonomy; SI = Social Influence; FSC = Facilitating Conditions; AC = Absorptive Capacity

Fig. 3 shows the path analysis results with standardised estimates of the loadings and the r-squared values of the indicator variables. The path relationship between the independent variables and dependent variables is shown in Table 1 below.

Based on Table 1, four variables have a significant and positive effect on the behavioural intention (BI) to use MOOCs. Considering the model fitness of SEM, the RMSEA was 0.071 (which was a threshold of 0.80) while $\chi 2/df$ ratio = 4.738 (which was below the threshold of 5). PA was found to have a positive and significant effect on BI ($\beta = 0.359$, $p < 0.01$), FCS had a positive and significant effect on BI ($\beta = 0.196$, $p < 0.01$), AC had a positive and significant effect on BI ($\beta = 0.478$, $p < 0.01$), SI had a positive and significant effect on BI ($\beta = 0.155$, $p < 0.01$). However, the results indicated that PE and EE had a non-significant effect on BI. Additionally, PA had a positive and significant effect on PE (($\beta = 0.705$, $p < 0.01$), and EE ($\beta = 0.821$, $p < 0.01$).

3.3. SEM analysis for Pakistan

Fig. 4 below presents the SEM analysis model for Pakistan and regression weights presented in the model.

Presented above are the path analysis results with standardised estimates of the loadings and the

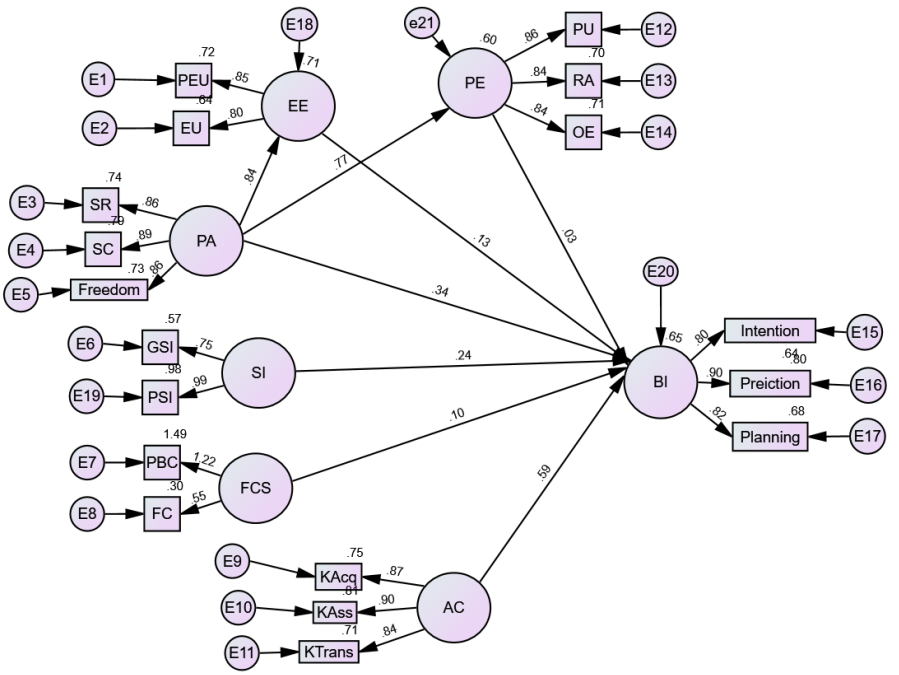


Fig. 4. SEM Analysis model results for Pakistan

Tab. 2. Path Analysis Regression weights for Pakistan

Paths	Estimate	S.E.	C.R.	P-Value
PE ← PA	.780	.045	17.517	***
EE ← PA	.791	.046	17.022	***
BI ← PA	.256	.075	3.403	***
BI ← FCS	.117	.031	3.831	***
BI ← EE	.106	.066	1.596	.110
BI ← PE	.022	.045	.496	.620
BI ← AC	.412	.029	14.092	***
BI ← SI	.153	.027	5.617	***
BI ← EE ←PA	0.084	-0.060	0.219	0.322
BI ← PE ←PA	0.018	-0.067	0.110	0.683

Note: *** significant at 0.01; ** significant at 0.05; BI = Behavioural intention to use; PE = Performance Expectancy; EE = Effort expectancy; PA = Perceived Autonomy; SI = Social Influence; FSC = Facilitating Conditions; AC = Absorptive Capacity

r-squared values of the indicator variables. The path relationship between the endogenous and exogenous variables is shown in Table 2 below.

The analysis of the above findings shows that four variables have a significant and positive effect on the behavioural intention to use MOOCs (BI), which are PA, FCS, AC and SI. Considering the model fitness of SEM, the RMSEA was 0.0621 (which was the threshold of 0.80) while $\chi 2/df$ ratio = 4.219 (which was below the threshold of 5). PA was found to have a positive and significant effect on BI ($\beta = 0.256$, $p < 0.01$), FCS had a positive and significant effect on BI ($\beta = 0.117$, $p < 0.01$), FCS had a positive and significant effect on BI ($\beta = 0.412$, $p < 0.01$), AC had a positive and significant effect on BI ($\beta = 0.153$, $p < 0.01$), SI had a positive and significant effect on BI ($\beta = 0.155$, $p < 0.01$). However, the results indicated that PE and EE have a non-significant effect on BI. Also, PA had a positive and significant effect on PE ($\beta = 0.780$, $p < 0.01$), and EE ($\beta = 0.791$, $p < 0.01$).

3.4. Multi-Group SEM analysis

Although all the research hypotheses have been addressed in the previous analysis results, it proved necessary to conduct a multi-group SEM analysis to compare the difference in effects of the independent variables on dependent variables between the two countries, Thailand and Pakistan. In this case, the moderating variable "country" was a categorical variable (1 = Thailand, 2 = Pakistan).

The first analysis tested the whole model to see if the two groups were different (whether there was a difference between Thailand and Pakistan). To do this, the Chi-square differences for the unconstrained and constrained model were compared. After running the model, the results of the default model were presented in Table 3 below.

From Table 3, the insignificant paths for both countries were trimmed (for Thailand BI←PE; BI←EE; and for Pakistan BI←PE) to get the unconstrained model. The Chi-square values for the uncon-

Tab. 3. Multi-group SEM analysis

	Thailand		Pakistan	
Paths	Estimate	P-Value	Estimate	P-Value
EE ← PA	0.685	***	0.672	***
PE ← PA	0.658	***	0.684	***
BI ← PE	0.02	0.492	0.034	0.231
BI ← EE	0.032	0.247	0.093	**
BI ← PA	0.249	***	0.205	***
BI ← SI	0.094	***	0.153	***
BI ← FCS	0.16	***	0.099	***
BI ← AC	0.404	***	0.405	***

Note: *** p-value < 0.01; ** p-value < 0.05

Tab. 4. Constrained and unconstrained model

Paths	Chi-Square	df	P-Value	Invariant?
Overall Model				
Unconstrained	705.845	16		
Fully Constrained	711.204	23		
Number of Groups		2		
Difference	5.359	7	0.616	YES
Chi-Square Threshold				
90% Confidence	708.55	17		
Difference	2.71	1	0.100	
95% Confidence	709.69	17		
Difference	3.84	1	0.050	
99% Confidence	712.48	17		
Difference	6.63	1	0.010	

strained model were recorded. To get the constraint model, the parameters were named to assume that they were equal for both groups. The difference between Chi-square and degrees of freedom for both groups (Thailand and Pakistan) were calculated and used to evaluate whether the two groups were invariant. The difference between the unconstrained and constraint model and the three thresholds (90%, 95% and 99% CL) is presented in Table 4.

3.5. Constrained and unconstrained model

Table 4 presented the constrained and unconstrained model for both countries.

The results presented in the table above show that that the Chi-square difference between the two models was 5.359, and the degree of freedom was 7. The p-value was 0.616 ($p > 0.1, 0.05, 0.01$). This indicated that the two groups (Thailand and Pakistan) were invariant. This implied that the models were not different across countries, or rather, the effects of dependent variables on independent variables were invariant (not different) between the two countries. Considering that the overall model was invariant, it did not make sense to do a path-by-path analysis for each independent variable.

4. Discussion of the results

The discussion of the results is presented in reference to the seven hypotheses of the study. The first hypothesis investigated the effects of performance expectancy on the behavioural intention to use MOOCs. For Thailand, the performance expectancy had an insignificant and negative effect on behavioural intention ($\beta = -0.048$, $p > 0.05$), while for Pakistan, the performance expectancy had a positive and insignificant effect on the behavioural intention to use MOOCs ($\beta = 0.022$, $p > 0.05$). It is observed that for both countries, the performance expectancy (perceived usefulness, relative advantage and outcome expectancy) did not have any significant effect on the behavioural intention of students to use MOOCs. Previous studies conducted in the same area had similar findings. The study conducted by Baj-Rogowska (2020) indicated that performance expectancy had a significantly positive relationship with the use of AutoCAD. Gupta and Dogra (2017) found that performance expectancy had a significant influence on traveller intention and habit to use technology.

The second hypothesis was on the effects of effort expectancy on the behavioural intention to use MOOCs. For Thailand, the effort expectancy had a negative and insignificant effect on the behavioural intention to use MOOCs ($\beta = -0.051$, $p > 0.05$). Similarly, for Pakistan, the effort expectancy had a positive and insignificant effect on the behavioural intention to use MOOCs ($\beta = 0.106$, $p > 0.05$). For both cases, the effort expectancy (perceived effort and the ease of use) did not have a significant effect on students to use MOOCs. Based on Alkhunaizan and Love (2012), effort expectancy had a significant influence on the behavioural intention to use mobile commerce technology. Wang and Wang (2010) also indicated that effort expectancy had a significant effect on the behavioural intention to use m-Internet.

The third hypothesis investigated the effects of social influence on the behavioural intention to use

MOOCs. For both Thailand and Pakistan, the social influence had a positive and significant effect on the behavioural intention to use MOOCs ($\beta = 0.155$, $p < 0.05$; $\beta = 0.153$, $p < 0.05$, respectively). For both cases, it implies that an increase in the level of social influence (general social influence and peer social influence) would result in an increase in the behavioural intention of students to use MOOCs. These findings are similar to those by Alraja (2016), whose study indicated that social influences had a significant effect on employees to adopt the electronic government. However, based on Jeng and Tzeng (2012), social influence does not have a significant influence on the behavioural intention to use a clinical decision support system (CDSS) for medical professionals.

The fourth hypothesis investigated the effect of facilitating condition on behavioural intention. For both countries, the results indicated that facilitating conditions had a significant and positive influence on the behavioural intention to use MOOCs ($\beta = 0.196$, $p < 0.05$; $\beta = 0.117$, $p < 0.05$). This implies that an increase in the observed aspects of facilitating condition (perceived behavioural control, facilitating condition) would result in an increase of the behavioural intention to use MOOCs by students. These findings agree with those by Sam and Baharin (2018), who indicated that facilitating condition significantly and positively affected the behavioural intention of users to employ an online booking system. Similarly, Almatari, Iahad and Balaid (2013) found that facilitating condition had a positive and significant effect on student intention to use mobile learning.

The fifth hypothesis investigated the effect of perceived autonomy on behavioural intention. For both countries, the perceived autonomy had a significant and positive effect on the behavioural intention to use MOOCs ($\beta = 0.359$, $p < 0.05$; $\beta = 0.256$, $p < 0.05$). Overall, an increase/decrease in perceived autonomy aspects (the sense of responsibility, self-confidence, and freedom) results in an increase/decrease of behavioural intention to use MOOCs by students. These findings were supported by literature, such as studies by Lakhal, Khechine and Pascot (2013) and Sierens, Vansteenkiste, Goossens, Soenens and Dochy (2009), who found a positive relationship between perceived autonomy and behavioural intention to undertake self-regulated learning. As indicated by Ahadiat and Dacko-Pikiewicz (2020), autonomy enables individuals to generate more positive results.

The sixth hypothesis was on the effect of absorptive capacity on behavioural intention. For both countries, the absorptive capacity has a positive and significant effect on the behavioural intention to use MOOCs ($\beta = 0.478$, $p < 0.05$; $\beta = 0.153$, $p < 0.05$). Comparing these findings, this study observed that in both cases, an increase in the level of absorptive capacity (knowledge acquisition, knowledge assimilation, and knowledge transformation) would result in an increase in the behavioural intention of students to use MOOCs. Knowledge management is an important part of strategic management (Formánek, 2015), and these findings are in line with those by Scuotto, Del Giudice and Carayannis (2017), who indicated that absorptive capacity had a significant influence on the behavioural intention to use SME innovations. Similarly, the study by Philbin and Kennedy (2020) found a strong need to deal with uncertainty and complexity in engineering projects, including effective knowledge and professional skills.

The last hypothesis aimed to compare a significant difference between Thailand and Pakistan results; thus, a multi-group structural equation modelling was used. Based on the results, the two countries were invariant as the Chi-square difference between the two models was 5.359, and the degree of freedom was 7. The p-value was 0.616 ($p > 0.1$, 0.05, 0.01). This indicated that the two groups (Thailand and Pakistan) were invariant. It implied that as far as various variables used in this study are concerned, students in Thailand and Pakistan had more or less the same responses. These findings could be confirmed by the fact that in the general SEM model, similar independent variables (perceived autonomy, facilitating conditions, absorptive capacity, and social influence) were found to significantly influence the behavioural intention to use MOOCs in Thailand and Pakistan.

Conclusions

The purpose of this study was to empirically investigate the behavioural intention of students to use MOOCs in Thailand and Pakistan, integrating the perceived autonomy and absorptive capacity in the UTAUT model applied in the analysis. The study focused on investigating the effects of various observed variables on the behavioural intention to use MOOCs in Thailand and Pakistan. The study concluded that four variables (social influence, absorptive capacity, facilitating conditions and perceived autonomy) significantly influenced the intention of students to use MOOCs in Thailand and

Pakistan. However, two variables (performance expectancy and effort expectancy) did not influence the student intention to use MOOCs in Thailand and Pakistan. The study also concluded that effort expectancy and performance expectancy did not mediate the relationship between the perceived autonomy and the behavioural intention to use MOOCs in Thailand and Pakistan. The data used in this study was collected from universities of Thailand and Pakistan, using similar questions. Therefore, it was important to investigate the variance of responses and the results of the two countries. A multi-group structural equation was used to find the variance in the effects of independent variables on dependent variables between the two countries. Applying the Chi-square technique, the results indicated that the findings between the two countries were invariant. It was, therefore, conclusive that the student intention to use MOOCs was the same for Thailand and Pakistan, as observed from the perspective of the influence from independent variables.

From the practical point of view, this study highlighted the significant factors worth evaluating, as far as adoption and implementing MOOCs by institutions of higher learning is concerned. First, the institution of higher learning could use the research findings to determine how students respond to the use of MOOCs, focusing on various aspects included in this study. For instance, how the aspects of social influence (general social influence and peer social influence), which were a significant exogenous variable, affect the intention to use MOOCs. From a scientific point of view, during the current COVID-19 pandemic, this study could prove very beneficial in determining the factors that the officials of higher institutions of learning should consider when implementing MOOCs and associated online learning programs to deliver quality education programmes to students. Thirdly, this study included the variable of absorptive capacity in the model to evaluate how the variable influenced the behavioural intention to use MOOCs, which turned out to be a significant determinant of the behavioural intention of students to use MOOCs. This study is limited by some aspects. First, this study was carried out in Thailand and Pakistan universities only. This should be considered when applying the study findings. Other institutions of higher learning, such as colleges, could be considered for such a study in the future. In the development of the theoretical model of this research, the study entirely referenced the UTAUT model and extended it by including two additional variables, i.e., perceived autonomy and absorptive capacity. Though the UTAUT model was developed by integrating eight other different models, such as Theory of Reasoned Action (TRA) and the Technology Acceptance model, this study recommended that future studies should consider including other theoretical frameworks, such as the UTAUT2 model, which incorporates such factors as hedonic motivation, price value and habit.

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Role of supplier evaluation criteria in risk mitigation related to purchasing process

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ABSTRACT
The article aims to present the role of supplier evaluation criteria in reducing purchasing risk. Before a purchasing enterprise starts cooperating with suppliers, it set specific requirements and expectations. The fulfilment of these requirements and expectations is verified through the evaluation of suppliers. Evaluation results should indicate potential risks that may arise in the development of partnership cooperation. The article includes the results of empirical research conducted using the computer-assisted telephone interviewing (CATI) technique in medium and large manufacturing companies operating in Poland. The results of the conducted empirical research indicate that companies wishing to partner with suppliers try to limit the level of risk associated with purchases. When evaluating suppliers, manufacturers focus mainly on reducing the risk associated with the defective technical quality of products, timely deliveries, delivery flexibility, time to restore continuity of deliveries, completeness of order fulfilment and delivery documentation, as well as price competitiveness. Also, in the evaluation of suppliers, companies operating in Poland are beginning to pay attention to the reduction of negative environmental impact.

KEY WORDS
supplier evaluation, risk in purchasing processes, organisational management standards

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Introduction

Supply chain management is a fundamental concept that has evolved to enable organisations to improve their efficiency and effectiveness in the global and highly competitive environment of the twenty-first century. This concept comprises processes connected with planning, completion and evaluation related to the flow of materials, equipment, information and human resources among organisations to ensure the effective and fast delivery of tangible prod-

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ucts and services between the supplier and the customer. Building a competitive advantage in the business-to-business (B2B) market, in particular, is subject to shaping the long-term partner relationships between companies and their customers and suppliers (Padgett et al., 2020). An individualised, trust-based approach towards the establishment of contacts, interests and the possibilities of cooperation, offers the negotiation and execution of transactions with parties guaranteeing their equivalent positions, called win-win (Ogunranti et al., 2021). A positive evaluation of these activities is essential in maintaining these relationships and a sign of readiness for further cooperation partners, by which several measurable benefits can be seen by each party. The condition of their feelings is the effective communication in the form and content of communication meeting the expectations of each partner (Chen et al., 2017; Murphy & Sashi, 2018). The activities of multinational corporations, which introduced the concept of sustainable development, are heavily focused on collaboration with their partners in the supply chain. Building partnerships with customers and suppliers can bring a supply chain many important benefits, such as:

- ensuring business continuity, together with the methodology developed for identification, analysis, and risk mitigation (associated with the product and the processes implemented in the supply chain);
- increased flexibility, efficiency and effectiveness of the processes;
- effective and rapid communication between the partners.

Partnerships usually result from a kind of evolution beginning with repeated transactions based on loyalty to the source of purchase and lead to confidence related to the positive image of a particular partner. Repeated transactions often transform into long-term connections in which relations are regulated by agreements. If the parties are happy with keeping to the arrangements established in the agreements, their cooperation may transform into a close partnership (Wagner, 2011). This may produce numerous benefits for the partners, namely: improved quality of products and services, prompter execution of orders, preferential prices, improved communication between the supplier and the recipient (a quicker and more complete exchange of information) and joint research and development. The benefits enhance the positive images of the partners (Pan et al., 2020). In some cases, a partnership between the supplier and the customer may transform into a strategic alliance, which is based on joint achievement of specific long-term goals. Increasingly, manufacturing companies focus on selecting key suppliers to build long-term relationships (Holmen et al., 2013). The purpose of these relationships is to create trust based on the joint improvement of the technical quality of product solutions, the reliability of supplies, the shortening of the cycle of process implementation and the improvement of their efficiency (Bakshi & Kleindorfer, 2009). Shaping relationships with suppliers in purchasing processes can include the following steps:

- defining requirements for purchasing sources;
- identification of potential suppliers;
- qualification evaluation and supplier selection;
- negotiating terms of cooperation;
- order fulfilment (including order transfer, delivery monitoring and documentation);
- evaluation of cooperation, which includes the periodic assessment of suppliers (points or indicators), as well as self-assessment of suppliers and their verification through audits;
- assessment of the impact of cooperation with the supplier on improving the efficiency of processes in the supply chain (Nagel et al., 2021).

To reduce the potential risk related to both products (a technical quality that does not meet legal requirements or the expectations of buyers/users), as well as disruptions related to timely and complete deliveries, the buyer companies evaluate suppliers (Kaur & Singh, 2021). To prevent potential risks related to technical problems with the product and its physical flow in the logistics processes, many purchasing companies endeavour to help their suppliers. This assistance is realised by setting supplier goals for the continuous improvement of products and processes, the assessment of the degree of their implementation, the evaluation of cooperation and supplier development programmes. The goals achieved by suppliers are verified by Supplier Self-Assessment Questionnaires, Performance Feedback Reports Cards and audits (Kai et al., 2010). Enterprises that are clients offer their partners supplier development programmes that focus on joint project implementation. Many large international concerns educate their potential and current suppliers by publishing Supplier Guidebooks or Supplier Manuals. The purpose of these guidelines is to help suppliers prepare for initial and periodic audits. The theoretical part of the article presents the evaluation of suppliers as a tool to reduce risk in purchasing processes. In this part of the article, the important role of the requirements for suppliers and the criteria for their initial and periodic assess-

ment is indicated. These requirements focus both on assuring the technical quality of the product, improving the operational efficiency of processes (ensuring timeliness, flexibility and continuity of deliveries), as well as reducing the negative impact on the environment. It was indicated that Performance Feedback Reports and audits are important tools for evaluating suppliers. The empirical part presents the results of surveys conducted in enterprises from three industrial sectors. The research results were discussed and interpreted, also referring to research results by other authors. The conclusions indicate that the requirements for companies that are purchasing sources are constantly evolving. To meet them, OEMs are increasingly offering supplier development programmes to their partners.

1. Literature review

1.1. Role of supplier evaluation in reducing risk in a supply chain

As previously mentioned, companies conduct multi-criteria evaluations to reduce the risk associated with supplier cooperation (Hawkins et al., 2020). This evaluation is particularly important for building long-term cooperation with suppliers. This assessment is frequently undertaken by periodic measures. The result of this assessment is recorded on the supplier scorecard (Helmi et al., 2016). The main evaluation criteria usually focus on the three most important parameters, which are Quality, Cost, and Delivery (QCD) (Torabi et al., 2015). Increasingly, supplier evaluation is not limited to three key parameters. During the evaluation, buyers often use a multi-criteria set of measures to determine the efficiency of suppliers (Aksoy & Ozturk, 2011). The result of this assessment allows for the qualification that determines the status of suppliers. Most often, because of assessment and qualification, companies divide suppliers into:

- preferred suppliers, characterised by a stable financial position and a leading position in the field of technical solutions, quality and timely deliveries as well as price competitiveness;
- active suppliers (with the prospect of becoming preferred suppliers);
- restricted suppliers on hold, having problems with maintaining technical quality and timely deliveries, with which the volume of purchase transactions is gradually reduced and not included in new projects;
- disqualified suppliers that do not meet the minimum requirements (Ulaga & Eggert, 2006).

Particular importance is attached to the evaluation of suppliers of basic products (main raw materials, parts, assemblies), as well as services (e.g., logistics, such as transport or storage). The frequency of the evaluation depends on the intensity of the purchasing processes. Many companies that relatively frequently place orders conduct monthly or quarterly evaluations of their partners. Other entities make such an assessment every six months or at least once a year (Timothy et al., 2020). In the case of purchasing infrastructure elements (machines, devices, vehicles, office equipment) where individual purchases may be made in cyclical periods, sometimes longer than a year, the given delivery is assessed. The same is applied to the assessment of Maintenance, Repair and Operations (MRO) suppliers. On the other hand, the evaluation of such suppliers mainly concerns the response to complaints, fulfilment of warranty obligations and the provision of service (assembly, installation, maintenance, training and response to technical problems related to operation). The evaluation of suppliers is of particular importance for enterprises that have implemented quality management systems for compliance with the requirements of the ISO 9001 standard (Su et al., 2020). The guidance in this standard indicates that purchasing organisations should determine and apply criteria for the evaluation, selection, monitoring of performance, and re-evaluation of external providers, based on their ability to provide processes or products and services in accordance with requirements. These organisations must provide updates and inform current suppliers of their requirements and expectations as well as control and monitor the performance of external providers (ISO 9001, 2015, 13–14). The latest amendment to this standard focuses on the continuous improvement of the organisation and the concept of risk management (Castillo-Martinez et al., 2021). For this reason, purchasing companies require suppliers to perform a risk analysis of products and related processes (Mokhtar et al., 2019). It should be noted that in some sectors, the requirements placed on suppliers in the field of quality management do not only concern compliance with the guidelines contained in the ISO 9001 standard. They are also extended by additional requirements contained in relevant documents (specifications, standards), such as the automotive sector (IATF 16949, VDA series 6), the aviation sector (AS/EN /JISQ 9100), the rail industry sector (IRIS), the medical device sector (ISO 13485), the primary packaging materials of medicinal products

sector (ISO 15378), the cosmetics production sector (ISO 22716), the packaging industry for food products sector (EN 15593), and the sector of fusion welding of metallic materials (ISO 3834). These sector standards focus on ensuring product and process safety through requirements for conducting risk analysis and identifying mitigation options. Business entities notice that the risk of threats comes not only from internal sources at the suppliers (such as the level of personnel qualifications, the condition of infrastructure and technologies that do not ensure the expected quality, timeliness and continuity of deliveries) but also from external sources (Kaur & Singh, 2021). The sources of risk of external threats resulting from the changing environment (legal, political, social, technological) as well as acts of God (such as floods, hurricanes, earthquakes) are particularly critical for partners operating in supply chains. Therefore, companies are increasingly looking for an effective methodology, the implementation of which would allow them to reduce the level of risk of threats in supply chains (Bakshi & Kleindorfer, 2009). For the efficient and effective functioning of processes in supply chains, such threats as technical failures, emergency situations, or accidents are important as they may disrupt the timely execution of orders as well as result in the loss of commercial or financial credibility of the suppliers. Examples of risks that may cause disruptions in the functioning of supply chains include:

- delivery of defective materials/infrastructure by suppliers, necessitating repairs and replacements delays and increased costs;
- untimely deliveries of materials/infrastructure;
- bankruptcy of subcontractors,
- shortage of employees with the required qualifications;
- accidents/breakdowns caused by difficult working conditions or non-compliance with health and safety rules.

1.2. Supplier evaluation criteria

Technical quality is a crucial criterion of supplier evaluation. It is most often measured by the level of defective deliveries, i.e., the percentage ratio of the number of defective products delivered to the total number of products delivered. In the case of mass products, it is measured using the Defective Parts Per Million (PPM) index (Lixandru, 2016). In the sectors (e.g., automotive or electronic), the permissible value of the PPM index is defined (Bebr et al., 2017). If the permissible value of the index is exceeded, the supplier may be eliminated from further cooperation (Pernot & Roodhooft, 2014; Jum'a, 2020). The assessment of technical quality may also include the assessment of the product's ability to perform functional functions, reliability, innovative solutions, safety, operation and the versatility of applications or ergonomics. This assessment is conducted during the operation of the product. The result of this assessment is used to decide on the further procurement of infrastructure elements (such as devices, means of transport, construction elements). On the other hand, price conditions are often assessed not only in relation to the purchase costs but also to other accompanying costs. These costs are incurred by buyers during the transaction (e.g., delivery, insurance), the costs related to the operation, as well as the costs related to nonconformities (e.g., the need to file a complaint and losses incurred related to the fact that the purchased merchandise cannot be used) or the cost of decommissioning. When analysing this criterion in the evaluation of a supplier, customers often consider the comparison of prices offered by the provider with those offered by the competition. It can also be seen that many companies are sometimes willing to accept higher prices, provided they are justified by the supplier (e.g., increases in the price of raw materials, energy, currencies, taxes, duties, or other state-regulated charges). A particularly important criterion for evaluating suppliers in the case of companies operating in accordance with the concept of just in time is timeliness and completeness of deliveries (Akso & Ozturk, 2011). A closely related criterion is also the supplier's flexibility with regard to the possibility of changing the order in terms of time, quantity, sequencing or the type of product purchased (Gligor, 2020). Increasingly, an important criterion for evaluating suppliers is their ability to quickly restore the continuity of processes and supplies (Shishodia et al., 2019). Such situations may take place in the case of events such as power failures, traffic accidents, fire/explosion during the production or storage process, epidemics/pandemics, sabotage, theft of goods, means of transport, documents, terrorism, or failure to meet contract terms by subcontractors. For this reason, Original Equipment Manufacturers (OEMs) increasingly require Disaster Recovery & Business Continuity Plans from suppliers of all tiers to reduce the risk of delayed deliveries (Kaur & Singh, 2021). These activities should prepare partners for the disruption that may occur by focusing on risk reduction and ensuring a resilient supply chain (Mensah & Merkuryev, 2014). For many buyer companies, important criteria for

assessing the efficiency of suppliers are their response time to complaints or technical problems related to the use (raw materials, parts or infrastructure elements). Furthermore, many companies, especially international corporations, by promoting the concept of sustainability, wanting to further reduce the risk associated with suppliers, pay attention to such aspects as pro-ecological activities or contractor's ethics (Govindan et al., 2015; Guarnieria &Trojan, 2019; Kartika et al., 2020). Environmental management systems for compliance with the requirements of the ISO 14001 standard, as well as health and safety management systems based on the guidelines of the ISO 45001 standard, are also increasingly important in the evaluation of suppliers (Yan et al., 2017). Requirements for suppliers in terms of pro-ecological activities can be noticed in the case of companies that have implemented the concept of environmental management. These companies expect suppliers to reduce/withdraw hazardous substances used in production, as well as to reduce the consumption of raw materials, energy, and production and packaging waste.

The emphasis on the implementation of the requirements relating to environmental management is linked to compliance with legal provisions, especially in the Directives and Regulations of the European Union, such as:

- RoHS (Restriction of Hazardous Substances) Directive EU 2015/863;
- WEEE (Waste Electrical and Electronic Equipment) Directive 2012/19/UE;
- VOC (Volatile Organic Compounds) Directive 2004/42/EC;
- EuP (Eco-design for Energy using Products) Directive 2009/125/EC;
- Battery and Accumulator Directive 2013/56/EU;
- Packaging Directive 2018/852EU;
- REACH (Registration Evaluation Authorisation and Restriction of Chemicals) Regulation 1907/2006/EC and 2020/878 EC.

The requirements contained in these directives are also often applied by companies from outside the European Union, especially large international companies producing high-tech products (mainly from the United States and Japan), such as Dell, HP, IBM, Motorola, Fujitsu, NEC, Panasonic, Sony, or Toshiba. An important element in the assessment of supplier-implemented environmental management system is to identify the environmental aspects and introduce actions included in the objectives and environmental programmes, which include specific tasks and measures of supplier assessment (Ferrón-Vílchez, 2016). Many companies expect suppliers to include a Material Safety Data Sheet (MSDS) with their product, especially chemical products (Winter & Lasch, 2016). The main purpose of MSDS is to provide information regarding potential hazards resulting from contact with hazardous substances or preparations, methods of minimising the risk, as well as how to proceed in the event of a hazardous situation that threatens the life or health of workers and the natural environment.

1.3. Supplier evaluation through performance feedback reports and audits

Many companies (especially international concerns) wanting to discipline providers directly (e.g., in the case of problems with technical quality, timely execution of orders) or wanting to assess the periodic development of their partners' potential require them to fill in Performance Feedback Reports and conduct supplier audits (Pun & Heese, 2014). Performance Feedback Reports are used for the self-assessment of suppliers in terms of their requirements related to the guidelines contained in international management standards (published by ISO or sector organisations, as well as specific measurable goals in terms of improving the efficiency and effectiveness indicators of processes. The information contained in these reports allows companies to evaluate the ability of suppliers to ensure and improve the level of technical quality, shorten the time cycles of processes, as well as possibility of reducing costs. It can also be often observed that international concerns focus on implementing the concept of sustainable development from their partners for reporting on the implementation of environmental goals. These goals are related to the consumption of resources (materials, energy sources, water), reducing environmental burdens resulting from the process, e.g., emission, sewage, waste (Demir et al., 2018). To an increasing extent, suppliers are required to implement the concept of Life-Cycle Assessment (LCA, based on ISO 14040 series of standards) and eco-design approach (Jenssen & de Boer, 2019). Many international companies also oblige suppliers to implement a code of conduct that focuses on ethical behaviour guidelines (Asif et al., 2019). Therefore, supplier self-assessment reports also include such activities as ensuring safe working conditions, the freedom of association for employees, fulfilling obligations towards employees (social, wage, working hours, health and safety) and anti-discrimination practices. The accuracy and reliability of the data contained in these reports are verified through

audits of suppliers (Li et al., 2016; Afshan, 2013). During supplier audits, operational processes, such as customer service, research and development, production preparation, quality control of processes and products, packaging, storage and shipment of products are assessed. Particular attention is paid to the documents used (procedures and instructions), records of processes (especially quality control), product identification, workplace safety, and environmental management. Audit results are an important source of information for both partners. For the supplier, the audit result shows to what extent the customer's requirements and expectations have been met and what activities require risk analysis and continuous improvement (Sarkar & Mohapatra, 2006). For the client, the collected observations constitute important information for the analysis of the risk and the opportunities of continuing cooperation with the partner. Increasingly, in order to assess the credibility of contractors and to start and continue cooperation, large international concerns commission a legal and economic analysis of partners in supply chains. This type of detailed supplier analysis is referred to as Supply Chain Due Diligence. This investigation may include the legal status, ownership interest, legal title to tangible and intangible goods, fulfilment of obligations towards stakeholders, financial assets, debt, profitability, financial liquidity, shares in other enterprises, type and scope of insurance and financial guarantees. The result of this investigation may determine the stability and durability of these relations in the future. The analysis of the Performance Feedback Reports and report audits also allows an effective evaluation of the activities conducted by suppliers related to the implementation of environmental programmes and the achievement of the goals focused on reducing the negative impact on the environment. During the audits, the following are assessed: the state of the infrastructure and the working environment to ensure the safety of processes and products, employee behaviour observed during process activities, the staff's environmental awareness, the emergency preparedness response, waste treatment, monitoring measuring equipment and control of operational processes. For a supplier, the audit result indicates the extent to which the requirements and customer expectations in terms of reducing the onerous impact on the environment have been fulfilled and what areas need improvement and continuous improvement (van den Brink et al., 2019).

2. Research methods

The subject of the conducted research was to define the importance of supplier evaluation criteria as indicators in the opinion of the surveyed production companies. The research was conducted between October and November 2019 using the Computer Assisted Telephone Interview (CATI) technique. The research involved 150 producers (employing over 49 people) who were enterprises from the automotive, electromechanical and chemical sectors operating in the Polish business-to-business (B2B) market. All companies participating in the study had an implemented quality management system compliant with the guidelines of the ISO 9001 standard. Almost half of the surveyed economic entities (47.33%) were enterprises with foreign capital (including large international concerns with global activity). The expectations of production companies towards their suppliers regarding the implementation of the sustainability concept were assigned a rank on a scale from one (being the least important criterion) to five (the most significant). The study was commissioned by a specialised research agency that conducted a targeted selection of companies registered in the Bisnode database, which is a business directory search platform.

3. Research results

The results of the conducted research indicate that in the opinion of the surveyed production companies, the most important criteria for evaluating suppliers as indicators of risk mitigation related to purchasing process include: the level of non-compliance related to the technical quality of the delivered products (defectiveness), timely deliveries, delivery flexibility, time to restore continuity of deliveries, completeness of order fulfilment and delivery documentation, and price competitiveness. Relatively important evaluation criteria also include the accuracy of forecasts for the implementation of orders agreed with the supplier, response time to complaints, the correctness of delivery documentation (no errors), response time to problems related to the use of products in the processes implemented by the purchasing companies. Detailed results of the research are presented in Tables 1 and 2.

Tab. 1. Importance of supplier evaluation criteria as determinants of risk mitigation related to purchasing process in the opinion of the surveyed production companies (general results and a comparison between the segments depending on capital and the number of employees, average)

Evaluation criteria	General N=150	Capital		Number of employees	
		Polish N=79	Foreign N-=71	50-250 N=65	251- N=85
The level of non-compliance related to the technical quality of the delivered products (defect in deliveries indicator)	4.82	4.87	4.76	4.84	4.80
Timely deliveries	4.78	4.80	4.75	4.77	4.79
Flexible deliveries	4.72	4.71	4.74	4.73	4.71
Time to restore continuity of supplies	4.66	4.61	4.71	4.65	4.67
Completeness of order fulfilment and delivery documentation	4.63	4.66	4.59	4.64	4.62
Price competitiveness	4.61	4.63	4.59	4.62	4.60
Response time to complaints	4.42	4.43	4.41	4.46	4.39
Reduction/phasing out of hazardous substances used in production	4.32	4.17	4.47	4.13	4.47
Response time to technical problems related to the use of products	4.31	4.24	4.37	4.27	4.33
Limiting the consumption of raw materials, energy and waste	4.20	4.22	4.18	4.08	4.30
Reducing the emission of pollutants into the environment	4.20	4.23	4.18	4.08	4.31

Source: elaborated by the author, results of the empirical study, 2019.

Tab. 2. Importance of supplier evaluation criteria as determinants of risk mitigation related to purchasing process in the opinion of the surveyed production companies (general results and a comparison between the segments depending on sector, average)

Evaluation criteria	Sector		
	Automotive N=63	Electromechanical N=36	Chemical N=51
The level of non-compliance related to the technical quality of the delivered products (defect in deliveries indicator)	4.81	4.80	4.84
Timely deliveries	4.84	4.69	4.76
Flexible deliveries	4.82	4.66	4.65
Time to restore continuity of supplies	4.75	4.53	4.63
Completeness of order fulfilment and delivery documentation	4.62	4.57	4.67
Price competitiveness	4.60	4.62	4.63
Response time to complaints	4.44	4.44	4.38
Reduction/phasing out of hazardous substances used in production	4.42	4.35	4.16
Response time to technical problems related to the use of products	4.30	4.38	4.25
Limiting the consumption of raw materials, energy and waste	4.06	4.37	4.27
Reducing the emission of pollutants into the environment	4.13	4.35	4.21

Source: elaborated by the author, results of the empirical study, 2019.

It is noteworthy that increasingly more companies use supplier evaluation criteria related to reducing the negative impact on the environment. These criteria include reducing/withdrawing hazardous substances used in production, limiting the consumption of raw materials/energy/waste, or reducing the emission of pollutant gases into the environment (which are converted into the so-called carbon dioxide footprint). Detailed analyses of the results of the conducted research were formed by making a comparison between the segments (of the surveyed companies) depending on the capital (Polish and foreign), the number of employees (medium and large side enterprises), and the sector (automotive, electromechanical, chemical).

4. Discussion of the results

The level of non-compliance related to the technical quality of the delivered products (defect in deliveries indicator) as a supplier evaluation criterion is essential for enterprises with Polish capital only. In turn, the timeliness of deliveries is significantly important for entities with domestic capital, mainly of the automotive sector. On the other hand, the flexibility of deliveries, as well as the time to restore the continuity of supplies, play a crucial role in the case of manufacturers with foreign capital operating in the automotive sector. Completeness of order fulfilment and delivery documentation as an evaluation criterion is of great importance for medium-sized companies (employing 50–250 employees) with domestic capital, mainly active in the chemical sector. In turn, the response time to the complaint is also particularly important for medium-sized companies operating in the automotive and electromechanical sectors. The limitation/withdrawal of hazardous substances used in production is particularly important for large manufacturers with foreign capital employing over 250 employees, operating mainly in the automotive sector. On the other hand, the response time to technical problems related to the application of products is also crucial for manufacturers with foreign capital employing more than 250 employees operating but active in the electromechanical sector. Evaluation criteria related to environmental management are of particular importance for large economic entities operating in the electromechanical and chemical sectors. These criteria oblige suppliers to limit the consumption of raw materials, energy and waste as well as to reduce the emission of pollutants into the environment.

Summarising the results of the conducted research, one should notice a relatively high level of awareness of Polish industrial enterprises about ensuring the continuity of processes in the supply chain. To ensure this business continuity, companies analyse the risk of threats in their processes and also ask suppliers to ensure the technical quality of products, timeliness/flexibility/completeness of deliveries, as well as environmental protection. The results of the research show that the greatest importance is to ensure technical quality, as it constitutes the most significant risk of threats to product users. Therefore, it is the most important criterion for evaluating suppliers. The results of the research also indicate that vital criteria for supplier evaluation concern critical requirements for delivery, such as timeliness, flexibility, and completeness. In the case of the risk of events related to disruptions in the execution of orders, the time of restoring continuity of supplies is essential. In the case of non-compliance related to technical quality, the response time to complaints or response time to technical problems related to the use of products is also important. It should also be noted that Polish industrial enterprises perceive the risk related to environmental pollution. Therefore, supplier evaluation criteria related to environmental protection include the reduction/phasing out of hazardous substances used in production, limiting the consumption of raw materials, energy and waste or reducing the emission of pollutants into the environment.

To compare the criteria indicated by respondents within groups differentiated by capital, the number of employees and the represented sector, non-parametric Kruskal-Wallis tests were performed. With regard to the grouping variable, which was the origin of the capital of the surveyed enterprises (Polish and foreign), statistically significant differences were determined, which related to three criteria: timely deliveries ($p^{**}<0.05$), completeness of order fulfilment and delivery documentation ($p^{**}<0.05$), price competitiveness ($p^{**}<0.05$). Enterprises with Polish capital indicated these criteria more often in relation to economic entities with foreign capital. Companies with Polish capital probably order more deliveries less frequently after expecting more competitive prices from suppliers. It should be noted that the results of the Kruskal-Wallis test concerning the selection of criteria by enterprises differentiated by size did not confirm a statistically significant difference in relation to all analysed criteria. The results of the Kruskal-Wallis test on the selection of criteria by companies differentiated by industry showed that for two criteria: reduction

phasing out of hazardous substances used in the product ($p^{**}<0.05$), and response time to technical problems related to the use of the product ($p^{**}<0.05$) confirmed statistically significant differences in the selection of these criteria for supplier evaluation. The criterion reduction phasing out of hazardous substances used in production was indicated more often by companies in the automotive sector (the sum of rand 82.98) than by producers in the chemical sector (the sum of rand 73.38), and least frequently by economic entities from the electromechanical sector (the sum of rand 64.42).

Therefore, companies operating in the automotive sector find important the response time to technical problems related to the use of product and compliance with legal requirements (EU directives) in the field of limiting the negative impact on the environment. The results of the Kruskal-Wallis test did not confirm statistically significant differences in the assessment of the analysed supplier criteria within the groups of respondents differentiated by capital, employees, and sector.

The research results on supplier evaluation criteria presented in the article are closely related to the current trends in scientific exploration focusing on mitigation risk in supply chains (Hawkins et al., 2020). The results of studies conducted by other researchers clearly indicate that the initial assessment through the use of self-assessment questionnaires and conducting supplier audits significantly reduces the risk associated with the purchasing process (Foerstl et al., 2010). Other researchers, on the basis of the results of their studies, indicate the main criteria for evaluating suppliers, which may disrupt the relationship between buyers and their suppliers. These are the technical quality of products, timely deliveries and price competitiveness (Alikani et al., 2019; Hosseini et al., 2019; Taherdoost & Brard, 2019). These criteria are the technical quality of products, timely deliveries and price competitiveness (Alikani et al., 2019; Hosseini et al., 2019; Taherdoost & Brard, 2019). It should also be noted that in recent years, more and more researchers, as a criterion for evaluating suppliers as a criterion of mitigation risk in supply chains, also indicate activities limiting the negative impact on the environment (Lahane & Kant, 2021; Esmaeili-Najafabadi, 2021). Therefore, it can be concluded that the results of empirical research carried out in manufacturing companies operating on the Polish market presented in the article are consistent with the current perceived global trends.

Conclusions

The considerations conducted on the basis of the literature analysis and the results of empirical research indicate that purchasing companies limit the risk associated with purchases by conducting supplier evaluations. The results of the conducted research indicate that the evaluation criteria focus mainly on the assessment of technical quality, as well as on the timeliness and flexibility of deliveries (the possibility of changes in orders). Increasingly important for evaluation is also the preparation of suppliers to restore supply continuity in crisis situations when the timeliness of order fulfilment may be threatened. An efficient response of suppliers is also important, especially in the event of complaints or problems related to the use of purchased products. Besides, increasingly more often, the evaluation also concerns the activities of suppliers related to reducing the negative impact on the environment (the elimination of hazardous substances, savings in the consumption of raw materials, energy, as well as the reduction of gas emissions to the atmosphere). The evaluation criteria are communicated to suppliers in the form of requirements. The fulfilment of these requirements is verified through self-assessment reports, audits and periodic assessment of the experience of cooperation with suppliers. For many companies, relationships with suppliers are not limited only to setting stringent requirements and continuous monitoring of their fulfilment. Increasingly, business entities notice that actions aimed at reducing risk in supply chains lead to building partnership ties with contractors. Partnership relationships are effectively formed in joint projects in the implementation of both product and organisational innovations. Innovations contribute to the improvement of effectiveness (by shortening the cycles of the execution time of activities) and the efficiency of processes (reducing costs). To increase the synergy of collaborative projects, an increasing number of OEMs are offering supplier development programmes (Glavee-Geo, 2019). These programmes are based on training, consultations and joint projects in the field of implementing both product innovations (improvement of technical parameters of products) and organisational innovations (Nasr & Jaber, 2019). These programmes contribute to reducing the risk of delayed and defective deliveries, improving work safety, reducing the negative impact on the natural environment as well as increasing the efficiency of processes by reduc-

ing costs (Zachary et al., 2019). Supplier development programmes are based on the win-win principle, which influences the formation of trust between partners.

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Methodology for multi-criteria assessment of working conditions as an object of qualimetry

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ABSTRACT

The article considers several modern scientific papers substantiating the need for assessing workplace safety and focusing on methods applied for the quantitative assessment of working conditions. The analysis found unsolved problems in qualimetry, which could lead to the development of new practical and generally applicable methods to effectively assess working conditions. The analysis proved the relevance of the topic and helped to determine the aim of the article, i.e., the development of a methodology for the quantitative assessment of working conditions in industries, considering harmful production factors. An exponential distribution, which belongs to the theory of extreme statistics, was proposed for the transition of heterogeneous single indicators of harmful factors into a dimensionless scale. Affine transformations were used to combine dissimilar scales, making it possible to divide segments on dissimilar scales into equal proportions. The article proposes a step-by-step method for determining a complex indicator of working conditions in industries. The proposed methodology allows management decisions that minimise the deviation in actual values of harmful factors from the optimal ones. The developed technique was tested at one specific metallurgical production site.

KEY WORDS

methodology for assessment, multi-criteria assessment, workplace safety, qualimetry object, complex indicator quality, management system

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Introduction

The successful development of a manufacturing enterprise, ensuring the competitiveness of products and achieving the set strategic goals requires not only improving technologies but also safe working conditions. Workplace safety management systems encompass the processes of identification, control, assessment and management, thus ensuring integrated support. An effective control system requires a scientifically grounded methodology for the quantitative assess-

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ment of harmful factors to control and minimise their impact on the human body, considering the characteristics of technological processes.

Technological processes are characterised by the weight and intensity of the work performed; type of working conditions; ergonomics of the workplace; technology safety; the level of technological discipline; the general organisation of the working process; and harmful and dangerous factors. A complex assessment of the state of workplace safety at an enterprise necessitates the quantitative indicators of harmful production factors that reflect applicable technological particularities.

Qualimetry methods are used to obtain quantitative indicators for various objects. Qualimetry is a subject of science that studies the methodology for quantitative assessment of the quality of objects and processes. Under the object of qualimetry, this article considers the system of harmful production factors for the health and life of people.

The system of harmful production factors, as an object of qualimetry, has several particularities: the possibility of performing measurements; various units and range of measurements; a different degree of influence on the human body; a different severity of the consequences of the disease; and the possibility of using special protective equipment. Such particularities determine the complexity of problem-solving in quantitative assessment of workplace safety in industries. To solve the problem, different-sized indicators of various factors must be put into a dimensionless scale, making a quantitative assessment of the generalised indicator of the state of workplace safety in industries.

Thus, the article aims to develop a methodology for the quantitative assessment of working conditions in production, considering the particularities of the system of harmful production factors.

The theoretical value of the article is the study of the possibility to use qualimetric methods for assessing working conditions in production. The practical value is the development of assessment methods that can be applied in different industries.

The article presents the literature review results related to the grounding of the need to assess workplace safety and focusing on methods used for assessing working conditions. Besides, it describes the research methodology and presents and discusses the research results. Furthermore, the article summarises the obtained results, explains the study limitations, and indicates the directions for further research. The last chapter also offers conclusions.

1. Literature review

The existing level of mechanisation and automation at industrial enterprises determines the impact inflicted on workers by a complex of harmful factors of the production environment and the labour process, i.e., vibration, noise, industrial aerosols, chemicals, psychological stress, moving and lifting loads manually, and fixed and forced working postures (Kukhar et al., 2018). Harmful production factors can cause occupational and general diseases (Schulte, 2005; Schulte et al., 2019). Thus, the mechanism for ensuring workplace safety at industrial enterprises should include processes for identifying and quantitative assessment of obvious and potential hazards to predict and prevent them.

In the article, Levanchuk et al. (2020) determined the safe duration of the exposure to a combination of unfavourable factors present in the working environment based on the application of the methodology for assessing the health risk of workers. The authors used regression formulas to predict the loss of health of locomotive crew drivers and determine age groups with a high degree of probability of a work-related and occupational pathology.

Several publications are devoted to the complex assessment of occupational health in an enterprise and the methodology for assessing the effectiveness of technical measures (Chebotarev & Sementsova, 2021; Shkrabak et al., 2020). The analysis of scientific papers demonstrated the absence of a substantiated mathematical apparatus in the publications. Regression models used as a mathematical analysis are ineffective, and scientific approaches are organisational.

Zavadskas & Turskis (2010) used the ARAS multi-criteria method for assessing the microclimate in an office building. This method uses an auxiliary function that determines the relative effectiveness of different options for assessment. This auxiliary function has a linear relationship between the relative results of the measured values and the weight factor of the criterion under consideration.

The decision matrix risk-assessment method (DMRA) was used by Gul & Guneri (2016) in the developed methodology for assessing risks in the field of safety and health protection. The authors proposed a fuzzy approach that allowed experts to use linguistic variables to assess two factors as parameters of the matrix method, eliminate the disadvantages of accurate risk assessment and reduce inconsistency in decision making.

Cherniak et al. (2020) proposed to use mathematical dependencies to assess the indicators of harmful factors, considering the maximum, minimum and optimal values of the factors and the shape variable. When changing the shape variable, different estimates are obtained on a dimensionless scale. To determine the shape variable, a hierarchy analysis method was applied, which allowed obtaining reliable values with a small number of experts. Similar mathematical relationships have been used to evaluate various other objects (Trisch et al., 2016; Ginevičius et al., 2015).

To prioritise occupational safety and health indices in the construction industry, Yarahmadi et al. (2016) used the TOPSIS method (Technique for Order Preference by Similarity to an Ideal Solution) (Beinoraitė, & Drejeris, 2014; Vavrek et al., 2017). This method is one of the most popular, most commonly used, theoretically based multi-criteria methods. The principle of the method is that from the variants being compared, the object that has the smallest difference from the best variant (by the total amount of all criteria) and the largest difference from the worst variant will be approved as the best.

Gul (2018) performed a critical review of the current state of research on risk assessment in the field of workplace safety using MCDM-based approaches.

The analysis of scientific materials showed that different multi-criteria methods for assessing harmful production factors are used in various production environments. However, each production is unique, and each workplace differs by hazardous and harmful factors. Therefore, this study aimed to develop a universal methodology for the quantitative assessment of working conditions in industries using qualimetric methods, considering their characteristics as an object of qualimetry.

2. Research methods

In the process of labour, a human is affected by harmful and dangerous factors, which can cause health deterioration and the loss of productivity. Different units and measurement ranges of harmful and hazardous factors lead to the difficulty in drawing a conclusion about a comprehensive quantitative assessment of the state of workplace safety.

For the transition of the dimensions of harmful and hazardous factors into a dimensionless scale, it is proposed to apply non-linear mathematical relationships between the measured indicators of harmful production factors and their estimates on a dimensionless scale. As mathematical dependencies, it is proposed to use the well-known dependencies derived by Gnedenko (1943) and previously applied for assessing the reliability of technical systems, which are related to the theory of extreme statistics. Using the theory of extreme statistics and the proposed mathematical relationships by Gnedenko, Harrington (1965) proposed a method for multi-criteria assessment of residential premises. Later, Azgaldov (1973) used it to evaluate various objects in the field of qualimetry. The methodology developed by Harrington is based on the application of a single mathematical relationship to the assessment of different, sometimes inconsistent assessment criteria. This dependence is expressed by the equation:

$$d_i = \exp[-\exp(-Y_i')] \quad (1)$$

where Y_i' — some dimensionless quantity, in some way related to any of the parameters of the factors Y_i.

In qualimetry, functional dependencies are used to assess the quality of various objects. Among the mathematical dependencies, linear and non-linear are used. In each specific case, it is necessary to justify the choice of a dependence. In the article, to assess working conditions in production, it is proposed to use a non-linear form of dependence (1). This is justified by the fact that the rate of change of estimates at the edges of the mathematical dependence has a lower rate than at the middle. That is, the values of harmful factors that are close to the limits of permissible values change slower than in the middle of the permissible values.

The scales on the axes are linked by a mathematical relationship (1). If a single indicator has a quantitative expression, the dependence (1) is used, and the quantitative assessment scale is converted into a logarithmic:

$$f(Y_i') = \ln(-\ln(-d_i)) \quad (2)$$

The correspondence of the two assessment scales is shown in Table 1 and Fig. 1.

To obtain a complex indicator of working conditions, it is proposed to determine the geometric mean of single quality indicators di, that is, it is proposed to make the transition from di to D according to the formula:

$$D = \sqrt[n]{\prod_{i=1}^{n} d_i} \quad (3)$$

where D — complex indicator of working conditions, and n is the number of hazardous and harmful factors.

Such presentation of a complex indicator of workplace safety conditions (2) is justified if at least

Tab. 1. Correspondence of two assessment scales

Dimensionless scale	0	0.2	0.37	0.63	0.8	1
Qualitative scale	Very bad	Bad	Satisfactory	Good		Excellent
Logarithmic scale	-3	-0.476	0	0.772	1.5	3

Source: elaborated by the authors based on Harrington (1965).

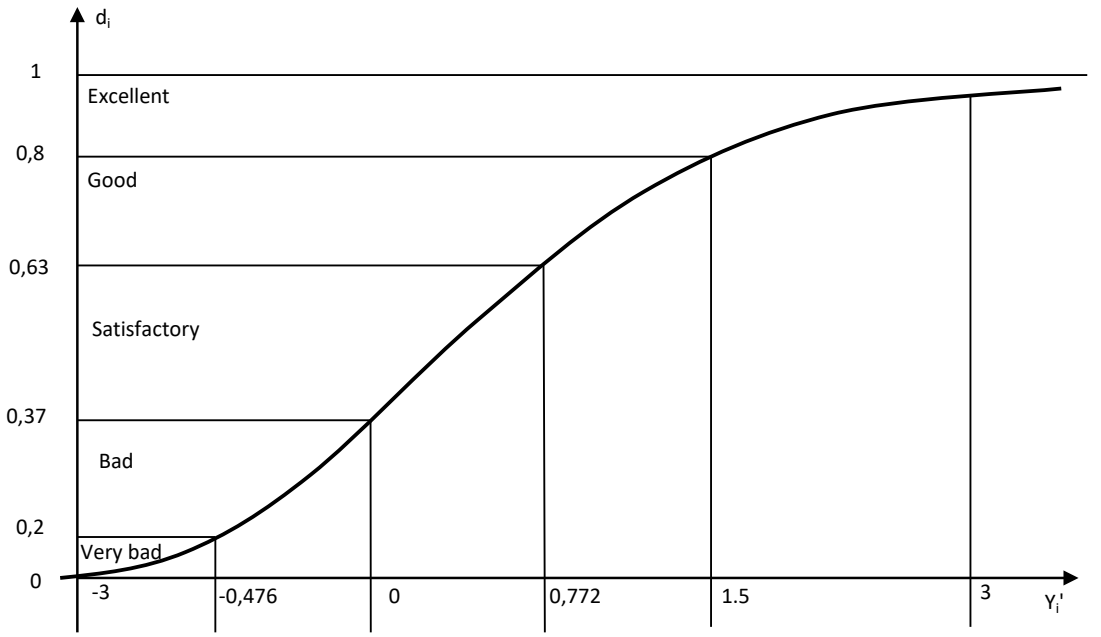

Fig. 1. General view of the mathematical dependence of two scales

Source: Harrington, 1965.

one of the single indicators $d_i = 0$, then D = 0. On the other hand, D = 1, then, and only then, if all $d_i = 1$ (i = 1, 2, ...,n). Therefore, a comprehensive assessment of the indicator of working conditions D, which is extremely sensitive to small values of single indicators di.

To determine the complex indicator of working conditions D, it is necessary to determine the transition from a separate dimensional factor Y_i to dimensionless Y'. To convert single measurable quality indicators into a dimensionless scale using function (1), it is necessary to have formulas for the transition from one scale to another. It is proposed to use an affine transformation for the transition to the dimensionless scale Y' for the measured indicators (Y_i), which keep the same distribution ratios of the segment. Consequently, if there are upper Y_{bi} and lower Y_{ni} boundaries of the Y_i indicator and the upper value Y'_b and lower Y'_n of the Y_i indicator correspond to them, then the values of the distribution of the segment are equal to each other. Hence, it follows that if

$$\lambda = \frac{Y_{bi} - Y_i}{Y_i - Y_{ni}} \quad (4)$$

$$Y' = \frac{Y'_b + \lambda Y'_n}{1 + \lambda} \quad (5)$$

If the upper Y_{bi} and lower Y_{ni} boundaries of different assessments of the quality factors Y_i are determined on the scale, then formulas (4 and 5) make it simple to find the normalised dimensionless separate factor indicator. These boundaries are proposed to be found with the help of a group of experts who deal with occupational safety issues. The group should have at least seven experts (a smaller number means a greater likelihood of accepting a random assessment). The decision is taken only if 2/3 of the members of the expert group agreed with the adoption.

The boundary of the estimates of the factor Y_i is determined as the arithmetic mean of the estimates given by each expert:

$$Y_{bi} = \frac{1}{n}\sum_{j=1}^{n} Yb_j \quad (6)$$

$$Y_{ni} = \frac{1}{n}\sum_{j=1}^{n} Yn_j \quad (7)$$

where Y_{bi}; Y_{ni} — the value of the boundaries of the estimates of factors, put down by the j-th expert, n — the number of experts.

Note that the complex indicator of working conditions is a quantitative, unambiguous, unique and universal indicator and can be used for multidimensional statistical control of factors and a workplace safety management system in industries.

This article proposes a step-by-step method for determining a complex indicator of working conditions in production:

- determine the list of harmful and dangerous factors in production;
- determine the maximum and minimum allowable value of each factor;
- establish the optimal (best) value of each factor;
- determine the intermediate boundaries of assessments of each factor, with the help of a group of experts, using formulas (6) and (7). The value of these boundaries is applied to the graphical model of the desirability function;
- perform measurements of each factor;
- convert the value of the measured factors Y_i into a dimensionless scale Y' using formulas (4) and (5).
- determine the single indicators of factors di using formula (1).
- using formula (3) to determine a complex indicator of working conditions, considering all single indicators.

3. Results and discussion

To confirm the efficiency of the developed methodology for assessing the safety of working conditions, research was carried out at a machine-building enterprise. The assessment considered harmful production factors in the foundry. The foundry was chosen as an example of a production site with harmful and dangerous factors for human health. The main harmful production factors in the foundry were microclimate (air temperature, relative air humidity, air velocity, and thermal radiation intensity), noise, and vibration.

The values of harmful production factors were measured and recorded at workplaces and in the working area within a month (31 days). A combined device FLIR EM54 was used to measure air temperature, relative air humidity and air velocity-. The intensity of the thermal radiation was measured with a thermal radiation radiometer "IR-meter". The measurement of noise level and general vibration was carried out with a digital sound level meter GM1351 and a vibrometer AR63A (GM63A). The permissible norms of harmful factors are determined at the enterprise following the current regulatory documents.

The obtained experimental values of the abovementioned indicators of harmful factors and the results of mathematical transformations are shown in Table 2.

Tab. 2. Results of the implementation of the methodology for assessing the safety of working conditions in industries

No.	Indicators of harmful factors	q_{min}	q_{max}	$q_{опт}$	q_i	λ	Ý	d_i
1	air temperature, °C	13	19	16	17	0.5	1.272	0.76
2	relative humidity, %	25	75	50	70	1	3	0.95
3	air velocity, m/s	0	0.5	0	0.1	-	-0.476	0.2
4	intensity of thermal radiation, W/m^2	0	140	0	94	1.8	-0.476	0.2
5	noise, dBA	60	80	0	65	3	1.897	0.86
6	local vibration, m/s^2	0	0.2	0	0.09	3	0.579	0.57

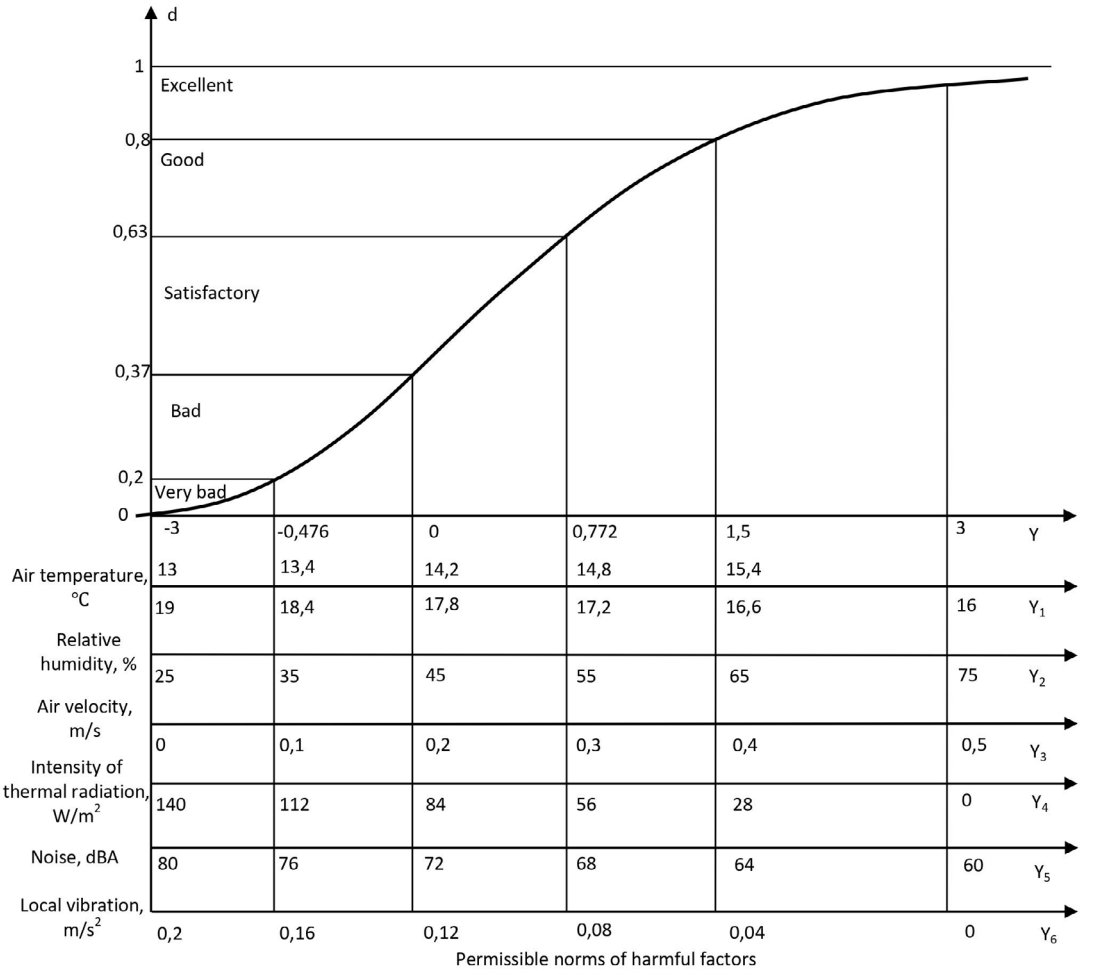

Fig. 2. Graphical model for assessing indicators of harmful factors

To adjust the scales for each indicator of a harmful production factor, it is necessary to divide the difference between its minimum and maximum value by the number of intervals that is on the corresponding intermediate scale. The graphical model for assessing the indicators of harmful factors is illustrated in Fig. 2.

Since the estimates of single indicators of harmful factors have the same measurement scale (0 – 1), it is possible to find a generalised indicator by applying one of the average values. In this case, the geometric mean is used.

$$D = \sqrt[n]{\prod_{i=1}^{n} d_i} = \sqrt[6]{0{,}76 \cdot 0{,}95 \cdot 0{,}2 \cdot 0{,}2 \cdot 0{,}86 \cdot 0{,}57} = 0{,}49 \qquad (9)$$

Thus, the use of the developed system of relationships between single indicators of harmful production factors and their values on a dimensionless scale provides a quantitative assessment of working conditions in industries. Using the proposed methodology, it is possible to take management decisions that lead to the minimisation of the deviation of the actual values of harmful factors from the optimal ones.

The proposed methodology is universal since it can be applied to assess working conditions in various industries. In individual cases, if necessary, the mathematical dependence (1) can be modified by multiplying it by dimensionless coefficients from 0 to 1. This way, it is possible to change the steepness of the relationship and obtain other estimates on a dimensionless scale. This will make it possible to manage the assessment process depending on the degree of influence of the harmful factor on human health.

It is not enough for the enterprise to ensure the permissible norms of harmful factors, but it is necessary to minimise their influence. This methodology allows making management decisions in increasing and decreasing the requirements for harmful factors in the workplace. Different values of estimates on

a dimensionless scale can be obtained by choosing a dimensionless coefficient. Future studies plan to use dependence (1) on the example of various industries using dimensionless coefficients.

Conclusions

Multi-criteria assessment of working conditions uses qualimetry instruments since they allow obtaining a quantitative assessment of production factors deemed harmful and dangerous to humans. The system of harmful production factors, as an object of qualimetry, has a number of particularities that should be considered when solving the problem of a quantitative assessment of workplace safety in production.

An exponential distribution, which belongs to the theory of extreme statistics, is proposed for transforming heterogeneous unit indicators of harmful factors into a dimensionless scale. To combine dissimilar scales, it is proposed to apply affine transformations that allow dividing segments on dissimilar scales in equal proportions.

The developed methodology was tested at one specific metallurgical production site. The applied methodology resulted in a generalised indicator of working conditions at the site.

The scientific value of the proposed methodology lies in its universality. It can be used to assess working conditions in various industries, using a different number of harmful factors and a different range of their measurement. In addition, factors can have different measurement scales. They may be defined by legal requirements or corporate requirements of the company. They can also be revised and changed to effectively manage the labour safety system. The limitations of this methodology are related to its application to quantifiable factors. The development of a methodology using verbal scales and qualitative assessments will be the aim of the following studies.

For the further development of the task, it is possible to consider the use of other mathematical relationships between the measured indicator of working conditions and the assessment on a dimensionless scale, which would consider various particularities of the qualimetry object. It is also desirable to study the assessments of the system of working conditions in a dynamic state, which means the process of changing assessments with time, allowing the application of control actions. It is advisable to develop a computer program based on the proposed methodology that would automate the assessment process.

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IoT-based smart cities: a bibliometric analysis and literature review

Katarzyna Szum

ABSTRACT

Modern cities face many challenges related to globalisation, metropolisation and digitalisation. The smart city concept, which has been gaining popularity in recent years, is considered an answer to their needs. One of the paradigms of modern smart cities is the Internet of Things. This article aims to identify the main research directions and trends in the scientific literature in the field of Internet-of-Things-based smart cities. The author of the paper conducted a bibliometric analysis of publications from 2012–2021, collected from the Web of Science, Scopus and IEEE Xplore databases. The methodology includes: (i) the selection of databases and key words, (ii) defining search criteria, (iii) data export, creation of an aggregate database and record selection, and (iv) the analysis of the results and identification of the major research trends. The study involved 1019 publications. The last stage of the research process identified the leading countries, institutions, journals, and authors in terms of publication activity, as well as the most frequently occurring terms. The key word analysis allowed identifying five main research directions: IoT application domains in smart cities, IoT architecture for smart cities, energy, security and privacy and data. Within each area, the main research themes have been identified, and selected publications have been reviewed.

KEY WORDS

smart city, Internet of Things, IoT, bibliometric analysis

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Introduction

Cities are complex structures undergoing constant change. They comprise many elements and multidimensional internal and external relations connecting them (Mora et al., 2017; Parysek, 2015; Scott & Storper, 2015). They are centres of service provision, places of creativity development, and innovation and knowledge transfer (European Commission, 2011). Numerous amenities offered by cities (better health care, educational and employment opportunities)

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make them a desirable direction for migrants from rural areas (Gosnell & Abrams, 2009), which results in the dynamic growth of cities and in the depopulation of rural areas. Currently, over 55% of the world's population lives in cities, and this percentage is projected to increase to 68% by 2050 (United Nations Human Settlements Programme, 2020). Rapid urbanisation makes cities catalysts for economic development at all spatial scales (national, regional and local) (United Nations Human Settlements Programme, 2020). However, the constant influx of population requires the development of transport, technical and communication infrastructure, and, thus, involves the need to occupy unused land and undertake tremendous investments. Enormous population growth can also lead to an increase in unemployment and a decrease in the quality of life of urban residents (Habibi & Asadi, 2011). Urban sprawl is also associated with several processes that affect the environment, including increased energy consumption and air pollution, reduced open space, and hindered waste management (Gil-Garcia et al., 2015). Thus, modern cities face new challenges related to management, logistics, communication, and environmental protection, ensuring high quality of life, and involving residents in decision-making processes (Winkowska et al., 2019; Winkowska & Szpilko, 2020). Years of research on cities specificity have led to many concepts of their development. Currently, additional growth factors are identified, among which advanced technologies play a leading role (Stawasz et al., 2012). The penetration of a broader technological trend — the Internet and ICT technologies — into the physical structures of the city has led to the smart city concept (Prado et al., 2016). It is an integrated system that uses advanced technologies to improve the flow of information, increase the quality of life of residents, and ensure sustainable economic development (Rudewicz, 2019). Smart cities constantly evolve, using the latest technological developments, making it difficult to create a single, consistent definition of the concept. Moreover, the fourth industrial revolution has brought new technologies with unprecedented scope and speed of development. It sheds new light on the functioning of smart cities (Ratti, n.d.). One pillar of the fourth industrial revolution is the Internet of Things. It is a vision of an integrated and distributed network of connected and communicating objects equipped with sensors, transmitters, and protocols (Xia et al., 2012; Zanella et al., 2014). IoT solutions allow cities to optimise the use of resources and increase the quality and availability of the services offered while reducing the cost of the activities (Zanella et al., 2014).

There are many publications in the literature addressing smart cities. However, no attempt has been made to provide a comprehensive picture of the current state of research on IoT-based smart cities from a bibliometric perspective. This article evaluates the scientific production in papers on IoT-based smart cities. The study included a bibliometric analysis of publications from 2012 to 2021 available in Scopus, Web of Science and IEEE Xplore databases. Bibliometric analysis is a method that enables the evaluation of scientific research, identification of main research directions and development trends in a given research area. It involves the application of quantitative techniques. The first stage of the study included an analysis of the publications, their subject areas, changes in their number over the years and identification of the most frequently cited articles, the most productive authors, journals, countries and institutions. In the second stage, the most frequently occurring key words in IoT-based smart cities were presented. The publication comprises four parts. The first part presents the theoretical basis of the smart city concept and the Internet of Things paradigm. The second and third parts consist of, respectively, a description of the methodology of the analysis and its results. The final part discusses the results and presents conclusions.

1. Literature review

1.1. Smart cities

Concepts of urban development have changed over the years, depending on current needs and trends (Saad et al., 2014). Since the birth of digital computing in 1950, digital technologies have penetrated cities. Before the beginning of the 21st century, there were already hundreds of publications addressing the digitisation of cities and its impact on urban residents. New concepts have emerged with information technology as the catalyst for urban development, i.e., computable cities or cyber cities (Kitchin et al., 2018). In the '90s, the concept of a smart city appeared in consideration of urban development (Dameri & Cocchia, 2011; Lombardi et al., 2012). Spread of the Internet and the development of information and communication technologies (Mohanty, 2016) allowed for easier creation, analysis, and transmission of information. It increased creativity and innovation and started creating an information society (Yun

& Lee, 2019). The expansion of the existing city model into a new digital dimension (Roberts, n.d.) required the integration of physical and virtual environments.

The potential of new technologies for the efficient and effective functioning of territorial units makes smart cities an attractive vision for researchers, policy-makers and urban planners (Yigitcanlar et al., 2019). Besides the smart city concept, related concepts appear in the literature, often used as alternative terms to smart city, i.e., digital city (Dameri & Cocchia, 2011; Ishida, 2017), wired city (Dutton, 2019; Strauss et al., 1996), information city (Hepworth, 1990), ubiquitous city (Shin, 2009), sensing/sensor city (D'Amico et al., 2020), tech city (Nathan & Vandore, 2014), hybrid city (Streitz, 2015) or electronic city (Tohidi & Jabbari, 2011). Undoubtedly, the smart city concept has become the most popular. However, a definite increase of interest in the scientific community occurred after 2011 (Winkowska et al., 2019), when the European Union started promoting the "smart" principle as one of the main directions of urban development (Dameri & Cocchia, 2011; Hajduk, 2016).

Despite its growing popularity, no single, coherent definition of a smart city has yet been created (Min, Yoon, & Furuya, 2019), and the literature provides many descriptions (Albino, Berardi, & Dangelico, 2015; Lima et al., 2020; Bashynska & Dyskina; 2018; Szpilko, 2020). Most often, the city's intelligence is assumed to be demonstrated by the existence of six "smart" dimensions: governance, economy, living, people, mobility and environment (Caragliu, Del Bo, & Nijkamp, 2011; Lombardi et al., 2012; Winkowska et al., 2019). Table 1 presents the description and characteristics of smart city dimensions.

It can be noted that the dimensions of a smart city do not focus only on technological aspects (Table 1). As Caragliu et al. pointed (2011) out, a city can be called smart if the investments (in transport infrastructure, information and communication infrastructure, and social capital) with simultaneous rational management of resources and inhabitants' involvement in the management process, ensure high quality of life and economic growth. Technologies play the role of tools that improve the functioning of the mentioned areas. According to Partridge (2004), a smart city is a place where technology facilitates access to public services, accelerates the flow of information and strengthens freedom of speech. According to Washburn et al. (2010), the concept is to use Smart Computing technologies to create key services and urban infrastructure elements. Bakıcı et al. (2013) defined it as a city having ICT and Web 2.0 technologies integrated with other activities to improve the management and facilitate the identification of new solutions in the field. All the taken actions aim to ensure the sustainable development of the city and the high quality of life for its residents. Although most definitions emphasise that technologies are only a tool to achieve certain goals, they are undoubtedly one of the key elements that prove the "intelligence" of cities (Gil-Garcia et al., 2015).

In recent years, technologies of unprecedented scope and efficiency have emerged. Many researchers emphasise that the changes taking place unequivocally signal the beginning of the next industrial revolution. Devices no longer serve only to connect users to the Internet but integrate the physical world with the digital world, creating cyber-physical systems (CPS) (Borgia, 2014). As Borgia pointed out, CPS are based on four key elements: advanced robotics, autonomous vehicles, knowledge-based work automation, and the Internet of Things. A smart city is

Tab. 1. Characteristics of smart city dimensions

Dimension	Characteristics
Smart people	A city that is socially and ethnically diverse, with highly qualified, experienced, open-minded, creative and engaged citizens.
Smart living	A city attractive to live in, with a high level of social cohesion, whose residents have a sense of security, good housing conditions, high quality medical and educational services, and access to culture.
Smart governance	A city with a transparent system of governance, using services that facilitate management and strengthen public participation, in which various actors are involved in decision-making processes.
Smart economy	A productive, innovative and entrepreneurial city with a flexible labour market and a positive image, undertaking national and international collaborations.
Smart mobility	A city that is communicatively accessible at all scales (local, regional, national and international), equipped with ICT infrastructure in which safe, sustainable and innovative forms of transport are used.
Smart environment	A city with a low level of pollution, where resources are managed rationally, energy consumption is optimised, alternative energy sources are used, and actions are taken to minimise the pressure on the environment.

Source: elaborated by the author based on Giffinger et al., 2007; Sikora-Fernandez & Stawasz, 2016.

one of the application areas of the Internet of Things (Pourghebleh & Navimipour, 2017).

1.2. Internet of Things

The term "Internet of Things" was introduced by Kevin Ashton in 1999. During a presentation for Procter & Gamble (P&G), he spelt out a vision of a world in which physical objects are connected to the Internet through sensors and a platform enabling a two-way exchange of information in real-time (Borgia, 2014). However, this concept gained popularity six years later, when the International Telecommunications Union presented a publication "The Internet of Things". This means that the IoT encompasses all objects, including those that were not previously part of a system (Swan, 2012). It is an integrated network that allows two-way communication between objects and users (human-to-human, thing-to-thing, human-to-things) through the use of embedded sensors, processors and actuators, and communication solutions (e.g., Bluetooth, Wi-Fi, Zigbee) (Group et al., 2015; Yaqoob et al., 2017).

The perception of the Internet of Things depends on the research context. According to Lynn et al. (2020), the literature presents two main conceptualisations of the IoT. The first includes only technical aspects, while the second also considers all interactions between technical and social elements. Based on Sethi and Sarangi (2017), the IoT is not a single technology but a combination of a wide range of integrated technologies and communication protocols. These can include, e.g., cloud computing, fog computing, edge computing, RFID, WSAN, machine-to-machine (M2M) communication, and IPv6 (Lynn et al., 2020). According to Atzori et al. (2010), the difficulties defining the Internet of Things also arise from the two-word structure of this term. It can be defined in two ways, from the perspective of the network (the internet-oriented vision) and things (the things-oriented vision). There is also a third semantic perspective (semantic-oriented vision). Based on Atzori, it is the most accurate view of the IoT as a common element of all three perspectives.

Numerous objects connected to the network generate vast amounts of data. According to Miorandi et al. (2012), the IoT is based on three basic functions of smart objects — traceability, communication, and interaction. Thus, IoT architecture should ensure security, reliability, scalability and interoperability of the entire system. The standard IoT architecture comprises five basic layers — perception (device), network (transmission), middleware, application, and business layer. The first layer includes physical objects and sensors (RFID, infrared sensors, 2D-barcode), which collect data from the environment. The network layer allows the data to be transmitted to the processing system using technologies such as Wi-Fi, Bluetooth, 3G, UMTS or ZigBee (Sethi & Sarangi, 2017). This data is received, stored, processed and analysed by the middleware layer using technologies, such as big data analytics and cloud computing. The application layer manages the IoT application areas (smart homes, smart farming, smart cities, etc.) based on the information extracted from the previous layer. Then, data passes to the business layer, where business models, diagrams, and charts are created to determine possible future courses of action (Khan et al., 2012).

IoT can support many areas of daily life, i.e., smart health, smart education, smart buildings, smart industry or smart agriculture. It can be said that smart cities cover most of the potential application areas of IoT solutions (Romanowski & Lewicki, 2018). Fig. 1 shows examples of application areas of the Internet of Things in different dimensions of a smart city.

IoT improves the functioning of educational and medical services (smart education, smart health), increases the comfort of living (smart homes, smart buildings), strengthens public safety (personal tracking), facilitates resource and waste management (smart waste management), environmental monitoring (air quality, water quality, noise level), and allows for early detection of threats and optimisation of energy consumption. It helps to manage smart transport networks (smart roads, smart parking, smart bike systems, smart public transport, smart vehicles, real-time traffic management). IoT solutions also bring many economic benefits, shaping smart sectors of the urban economy (smart industry, smart retail, smart tourism). They also increase the transparency of city government activities and allow residents to participate in shaping city development (Mehmood et al., 2017; Zanella et al., 2014).

Despite its many benefits, the Internet of Things also brings a number of challenges related to (Elkhodr et al., 2016; Khan et al., 2012):

- ensuring privacy and security of:
  - information, which is related to the use of multiple identification technologies (i.e., RFID, 2D barcode) and risks of private information leakage;

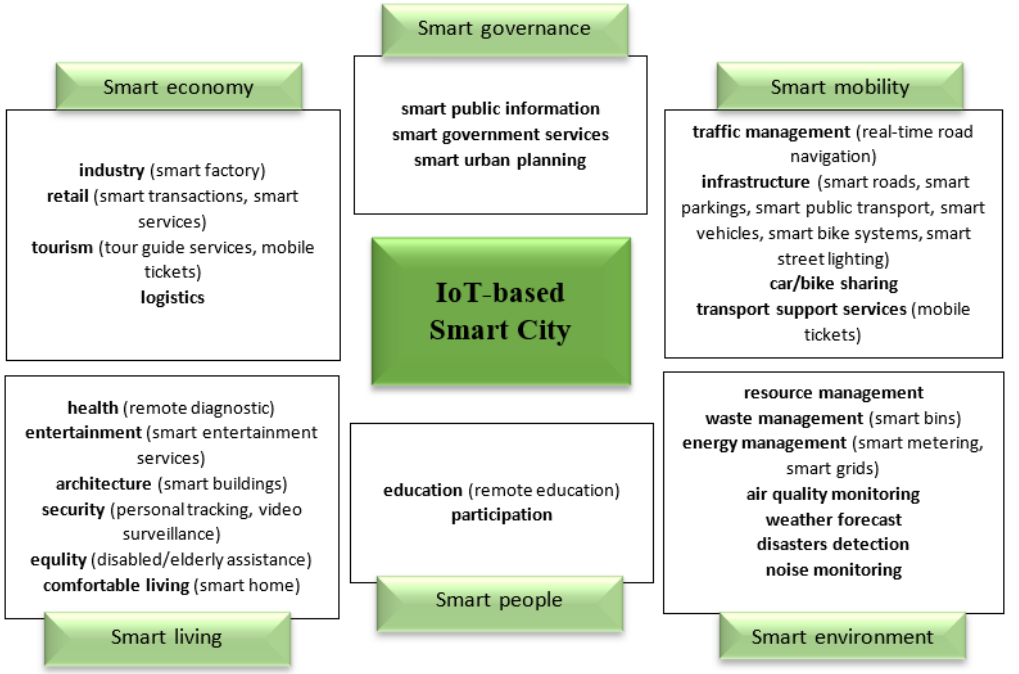

Fig. 1. Applications of IoT in smart cities

Source: elaborated by the author based on Borgia, 2014; Hui et al., 2017; Zanella et al., 2014.

- objects, considering a large number of objects at different locations, posing a risk of unauthorised interference;
- network, dealing with the transmission of vast amounts of data over a wireless network, which can result in an overload and create a risk of unauthorised access;

- data encryption;
- object management (switching on and off, changing target connection networks, detecting failures, updating software);
- identity management — numerous objects connected to the network create problems with their nomenclature and identification;
- integration — connecting multiple devices with different parameters and specifications can make it difficult to achieve interoperability of the entire system;
- optimisation of energy consumption — the increasing number of smart devices and data transfer speeds are associated with higher energy consumption.

The effective implementation of the IoT concept in cities is influenced not only by technological issues but also by social, economic or political aspects. The factors that determine the development of smart cities include the level of digital skills of urban residents, their openness to change, the effectiveness of city authorities in activities aimed at implementing the concept, and the level of investment in research and development activities.

2. Research methods

In an era of the increasing number of publications, the identification, synthesis, analysis and critical evaluation of their content is challenging. This has led to a growing interest in more systematic approaches to the evaluation of scientific production, with a greater emphasis on quantitative methods of data analysis (Ertz & Leblanc-Proulx, 2018; Keathley-Herring et al., 2016). Frequently used methods include bibliometric analysis (Keathley-Herring et al., 2016), which involves the use of quantitative techniques to identify the current state and developmental trends in a research area. Assessments based on bibliometric data are now the basis of research evaluation (Bornmann & Haunschild, 2017; Ellegaard & Wallin, 2015). The aim of the bibliometric analysis is to provide knowledge about the main research directions in a field, research trends, changes in the number of publications over the years, the most productive authors, journals, countries, or research units (Niñerola et al., 2019). Authors use this method both for "mature" research areas (Tran et al., 2019;

Winkowska et al., 2019) and areas with fewer publications (Carrión-Mero et al., 2020; Lim et al., 2021; Tomaszewska & Florea, 2018; Winkowski, 2019). The bibliometric analysis methodology used to achieve the aim of this study is shown in Fig. 2.

The proposed methodology comprises four stages — the selection of scientific databases and key words, the selection of inclusion criteria, data export and aggregate database creation (including their selection), and the analysis of the publication set (Fig. 2). The last stage was divided into two sub-stages. The first involved identifying the most productive countries, organisations, journals, and authors, while the second stage identified the most frequent key words. Then, based on the term analysis, the review of the publication set, and the consultation with an expert, the terms were grouped into thematic clusters depicting the main research directions. Within each cluster, major thematic threads were identified, and selected publications were reviewed.

The bibliometric analysis was performed based on publications available in Web of Science, Scopus and IEEE Xplore databases. It covers publications containing the phrases "smart cit*" and "internet of things" or "iot" in the title. This restriction was made after an analysis of the initial search results, which included publications containing the indicated phrases in the title, abstract, or key words. Next, selected inclusion criteria were applied. The search was conducted for materials published between 2012 and 2021 in English. Articles, conference papers, books, book chapters, reviews and early access were considered. Other publication types (editorial materials, retracted publications, data papers, conference reviews, notes, short surveys, letters, undefined) were rejected. The results of the first search are presented in Table 2.

After searching the terms in titles, abstracts and key words, 4534 records were obtained in the Web of Science, 7809 in Scopus and 4391 in IEEE Xplore

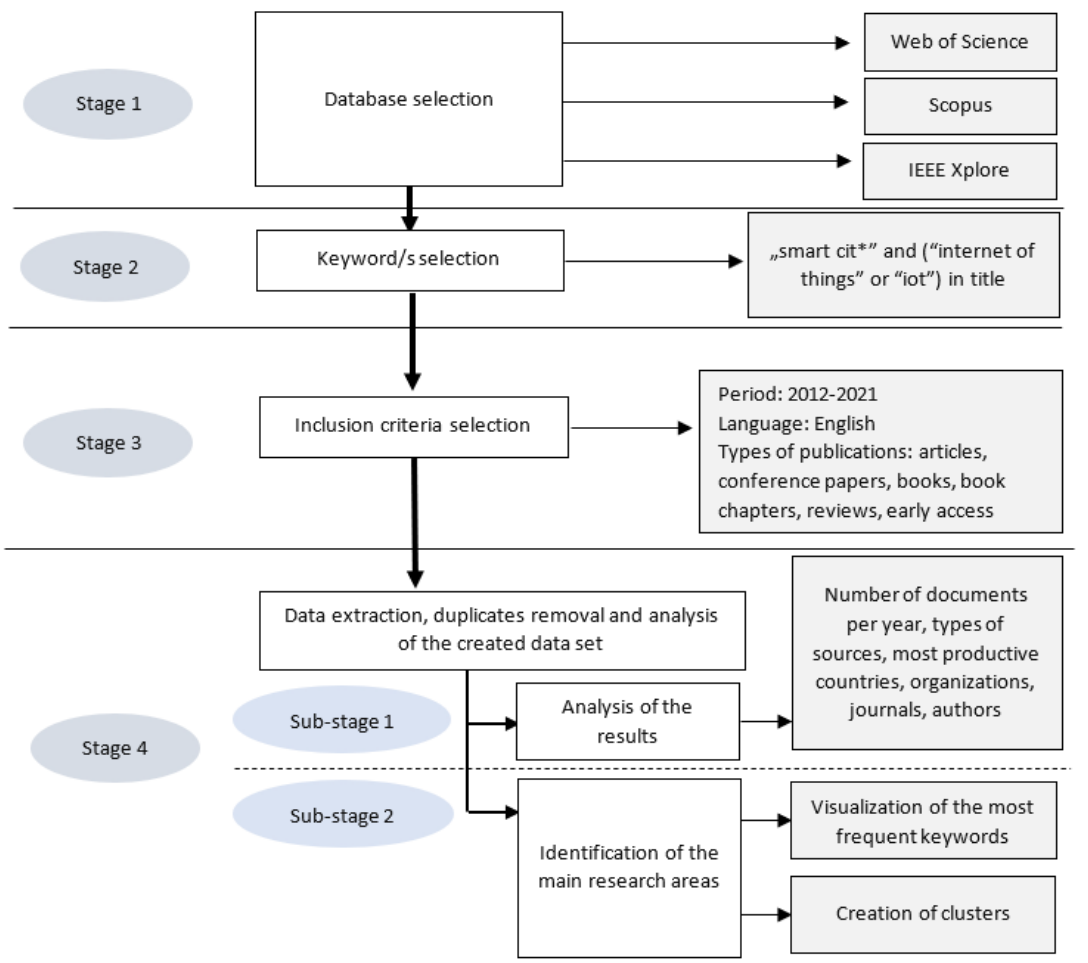

Fig. 2. Proposed methodology for bibliometric analysis

Tab. 2. Results of the first search

Stage	Web of Science	Scopus	IEEE Xplore
Research query	TS=(„smart cit*") AND TS=(„internet of things" OR iot)	TITLE-ABS-KEY („smart cit*") AND TITLE-ABS-KEY („internet of things" OR iot)	„All Metadata": „smart cit*" AND („All Metadata": „internet of things" OR „All Metadata": „iot")
Number of articles before inclusion criteria	4534	7809	4391
Number of articles after inclusion criteria	4482	7451	4389

Source: elaborated by the author based on the Web of Science, Scopus and IEEE Xplore databases.

Tab. 3. Results of the second search

Stage	Web of Science	Scopus	IEEE Xplore
Research query	TI=(„smart cit*") AND TI=(„internet of things" OR iot)	TITLE(„smart cit*") AND TITLE(„internet of things" OR iot)	"Document title": "smart cit*" AND ("Document title": "internet of things" OR "Document title": iot)
Number of articles before inclusion criteria	661	978	459
Number of articles after inclusion criteria	631	945	459

Source: elaborated by the author based on the Web of Science, Scopus and IEEE Xplore databases.

(Table 2). The adoption of inclusion criteria resulted in 4482, 7451, and 4389 records, respectively. The number of publications dated 2021 was 207, 616 and 292, respectively. A preliminary analysis of the results showed that many publications did not serve the aim of the study. Therefore, the search was limited to publications containing the indicated phrases in the title only. Results of the second search are presented in Table 3.

Entering queries yielded 661 records in Web of Science, 978 in Scopus, and 459 in the IEEE Xplore database. Finally, the adopted inclusion criteria resulted in 631, 945, and 459 records, respectively (Table 3). In 2021, 31 publications were registered in the Web of Science database, 72 in Scopus, and 26 in IEEE Xplore.

The file from each of the databases was downloaded. Next, one aggregate file containing 2032 records was created. After removing duplicates and incomplete records, a final set of 1019 records was analysed. The interest in the subject over the years, major research areas, most productive journals, organisations, countries, and authors, and most cited articles were presented. A graphical representation of the most frequently occurring key words and a map which reflects the co-occurrence of key words in the analysed set of publications were showed. The construction of the map in VOSviewer software required a thesaurus file (van Eck & Waltman, 2018).

3. Research results

The first stage of the study comprised the analysis of the interest in the issue over the years, identifying the predominant publication types and the major subject areas. These results were presented separately for each of the three databases. Fig. 3 shows the changes in the number of publications over the years.

For both databases, the number of publications rose during almost the entire period (2012–2019), with a slight decrease in 2020 (Fig. 3). We can observe a definite increase in interest after 2016. The total number of citations for publications indexed in the Web of Science database was 10198, the Scopus database — 16486, and the IEEE Xplore database — 8328. The number of uncited publications was 195, 258, and 163, respectively.

Fig. 4 shows the structure of publications by document type. In the Web of Science database, the largest part was comprised of articles (49.0%) and conference papers (44.6%). In the Scopus database, 50.8% were conference papers, while almost 41% were articles. In the IEEE Xplore, the largest part was

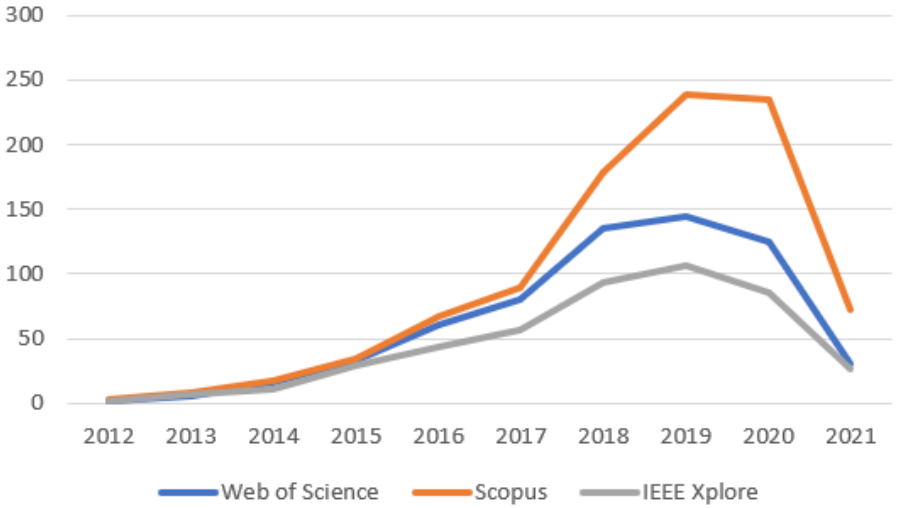

Fig. 3. Number of publications in the field of IoT-based smart cities in the Scopus, Web of Science and IEEE Xplore databases (indexed from January 2012 to March 2021)

Source: elaborated by the author based on the Web of Science, Scopus and IEEE Xplore databases.

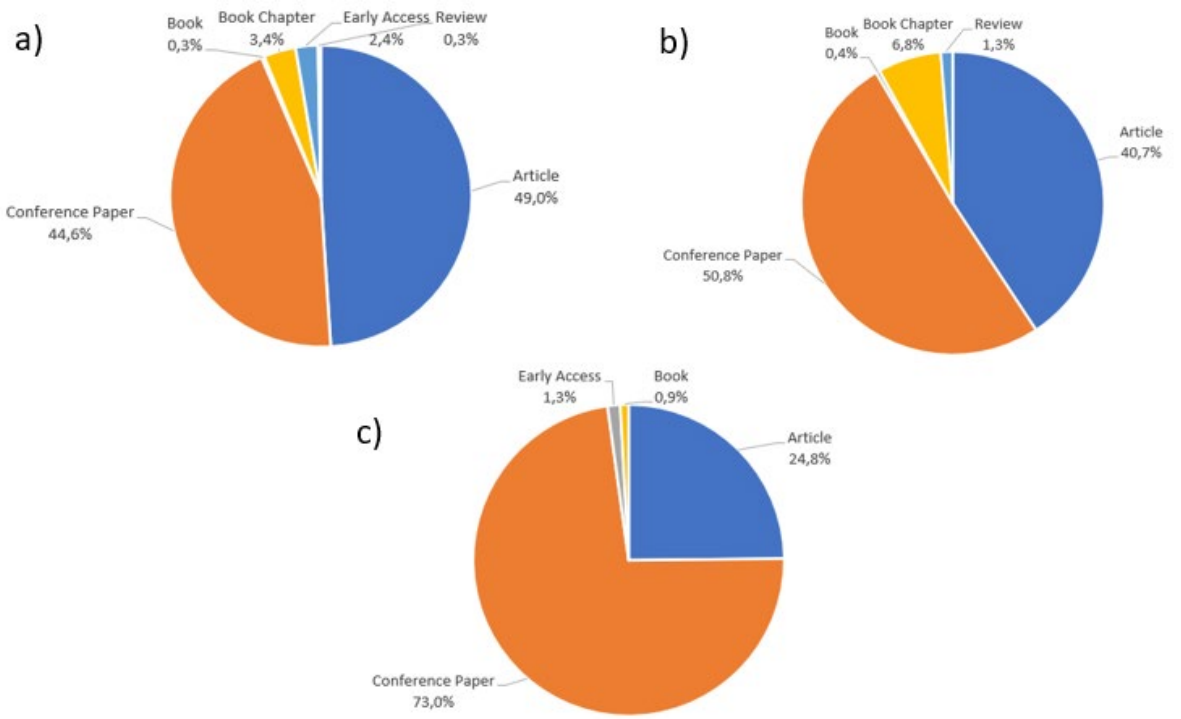

Fig. 4. Type of documents: a) Web of Science, b) Scopus, c) IEEE Xplore

similarly conference papers (73.0%) and articles (24.8%).

Most publications in both databases are assigned to the areas of computer science and engineering, 34.1% and 26.3% in the case of the Web of Science database, and 37.6% and 23.2% in the case of the Scopus database, respectively. A significant proportion of publications in Web of Science are also

Tab. 4. Most productive countries, organisations, journals and authors

No	Item	Np	%oft	Average citation count		
				WoS	Scopus	IEEE xplore
	Most productive countries					
1	India	254	24.9%	6.3	6.0	4.5
2	United States	153	15.0%	11.5	14.5	14.6
3	China	133	13.1%	9.8	15.7	7.7
4	Italy	74	7.3%	59.7	71.4	98.8
5	United Kingdom	66	6.5%	25.0	34.4	7.2
6	Spain	58	5.7%	19.1	75.9	113.7
7	Saudi Arabia	57	5.6%	9.0	13.0	11.3
8	South Korea	47	4.6%	22.0	26.3	4.5
9	Pakistan	46	4.5%	9.8	12.1	4.1
10	Germany	39	3.8%	30.7	38.0	17.5
	Most productive organisations					
1	National Institute of Technology Nit System	18	1.8%	14.6	11.8	2.8
2	COMSATS University Islamabad	16	1.6%	15.6	21.2	7.6
3	King Saud University	15	1.5%	25.3	30.6	15.5
4	Commonwealth Scientific Industrial Research Organisation CSIRO	13	1.3%	49.3	74.0	23.8
5	Fraunhofer-Gesellschaft	13	1.3%	19.5	27.8	29.7
6	Universidad de Cantabria	12	1.2%	36.9	53.4	7.6
7	Chinese Academy of Sciences	12	1.2%	10.0	11.0	6.7
8	Indian Institute of Technology System IIT System	10	1.0%	7.5	8.8	1.8
9	Qatar University	10	1.0%	19.8	14.2	8.3
10	Centre National De La Recherche Scientifiquecnrs CNRS	10	1.0%	2.7	5.9	1.4
11	Amity University	10	1.0%	5.8	9.2	5.0
12	ITMO University	10	1.0%	13.8	35.7	30.7
	Most productive journals					
1	IEEE Internet of Things Journal	41	4.0%	116.7	134.8	93.5
2	Sensors	33	3.2%	12.3	18.6	N/A
3	IEEE Access	25	2.5%	8.4	12.5	5.9
4	Future Generation Computer Systems-The International Journal of Escience	17	1.7%	35.4	43.1	N/A
5	Sustainable Cities and Society	15	1.5%	6.8	9.8	13.6
6	IEEE Network	12	1.2%	17.8	24.9	N/A
7	Geopolitics, History, and International Relations	10	1.0%	N/A	2.2	N/A
8	Computer Communications	8	0.8%	2.67	4.71	N/A
9	Journal of Advanced Research in Dynamical and Control Systems	8	0.8%	N/A	1.38	N/A
10	International Journal of Advanced Computer Science and Applications	8	0.8%	0.86	1.38	N/A
	Most productive authors					
1	Zaslavsky, A.	10	1.0%	65.9	96.4	30.7
2	Anagnostopoulos, T.	9	0.9%	10.7	34.9	23.0
3	Guizani, M.	8	0.8%	38.6	83.4	27.7
4	Sanchez, L.	8	0.8%	52.6	72.4	7.5
5	Serrano, M.	8	0.8%	6.7	12.6	6.5
6	Munoz, L.	7	0.7%	59.9	71.6	9.7
7	Sotres, P.	7	0.7%	59.6	83.3	8.3
8	Al-Turjman, F.	7	0.7%	10.2	13.4	N/A
9	Santana J.R.	6	0.6%	69.2	98.6	12.0

Abbreviations: NR — number in ranking, NP — number of publications, %ofT — percentage of the total number of publication (1019), N/A — not applicable.

assigned to the telecommunications area (17.8%). However, it should be noted that the names of the areas vary depending on the database.

To increase the reliability of the results, the author exported records from each database to *.csv files and then merged them. The combined file contained 2032 records. After removing duplicate and incomplete records, 1019 records were obtained.

The next step was to analyse the created set for the most productive countries, journals, organisations, and authors (Table 4). The largest number of publications came from India (254 publications), the United States (153), and China (133). The top ten most productive countries included four European states — Italy, United Kingdom, Spain and Germany. Considering the affiliation of the authors, the highest number of publications came from the National Institute of Technology Nit System network (18), COMSATS University Islamabad (16) and King Saud University (15). The Commonwealth Scientific Industrial Research Organisation CSIRO was ranked fourth (13 publications). Compared to other organisations in the ranking, it had the highest average number of citations in the Web of Science and Scopus databases. In the ranking of the most productive journals, the first position was held by IEEE Internet of Things (41 publications). Articles published in the IEEE Internet of Things Journal also received the highest number of citations in each database. This was followed by Sensors with 33 publications and IEEE Access with 25 publications. Three of the top ten most productive journals were from the Institute of Electrical and Electronics Engineers.

The authors with the highest number of publications were Zaslavsky (10 publications) and Anagnostopoulos (9 publications). Zaslavsky' most cited publication was "Sensing as a service model for smart cities supported by Internet of Things" from 2014. Anagnostopoulos' most cited article was "Challenges and Opportunities of Waste Management in IoT-Enabled Smart Cities: A Survey" from 2017.

Next, the most frequently cited publications were identified (Table 5). The total number of citations was 4890 for the WoS and 6555 for the Scopus. The top

Tab. 5. Ten most cited studies on the Internet-of-Things-based smart cities area

No.	Citation count			Publication title	Author	Journal
	WoS	Scopus	IEEE Xplore			
1	2170	2940	2694	Internet of Things for Smart Cities	(Zanella et al., 2014)	IEEE Internet of Things Journal
2	566	733	653	An Information Framework for Creating a Smart City Through Internet of Things	(Jin et al., 2014)	IEEE Internet of Things Journal
3	446	574	N/A	Sensing as a service model for smart cities supported by Internet of Things	(Perera et al., 2014)	Transactions on Emerging Telecommunications Technologies
4	384	542	500	Long-range communications in unlicensed bands: the rising stars in the IoT and smart city scenarios	(Centenaro et al., 2016)	IEEE Wireless Communications
5	317	384	N/A	SmartSantander: IoT experimentation over a smart city testbed	(Sanchez et al., 2014)	Computer Networks
6	260	370	N/A	Urban planning and building smart cities based on the Internet of Things using Big Data analytics	(Rathore et al., 2016)	Computer Networks
7	230	330	318	Everything You Wanted to Know About Smart Cities The Internet of Things is the backbone	(Mohanty, 2016)	IEEE Consumer Electronics Magazine
8	211	267	259	Enabling Smart Cities through a Cognitive Management Framework for the Internet of Things	(Vlacheas et al., 2013)	IEEE Communications Magazine
9	164	223	107	Internet-of-Things-Based Smart Cities: Recent Advances and Challenges	(Mehmood et al., 2017)	IEEE Communications Magazine
10	142	192	N/A	A Review of Smart Cities Based on the Internet of Things Concept	(Talari et al., 2017)	Energies

Abbreviations: N/A — not applicable.

ten publications included two articles published in IEEE Communications Magazine, IEEE Internet of Things Journal and Computer Networks, and one in Transactions on Emerging Telecommunications Technologies, IEEE Wireless Communications, IEEE Consumer Electronics Magazine, and Energies. The three most cited publications are from 2014. The most cited publication (WoS: 2170, Scopus: 2940, IEEE Xplore: 2694) was the article "Internet of things for smart cities" by Zanella et al. It was followed by the article "An information framework for creating a smart city through internet of things" by Jin et al. (2014). The total number of citations was almost four times less than for the previous publication (WoS: 566, Scopus: 733, IEEE Xplore: 653). Both articles were published in the IEEE Internet of Things Journal. Six articles were from journals of the Institute of Electrical and Electronics Engineers.

The last step of the bibliometric analysis was the identification of the most frequent key words. For this purpose, VOSviewer software was used. The generated set included words having an equal meaning (abbreviations or repetitions) and words that were not related to the subject of analysis. The first set was therefore modified using the prepared thesaurus file. Key words used in search and irrelevant terms were eliminated. Equivalent terms and abbreviations were also replaced. The final set of items contained 54 words. Fig. 5 presents the most frequent terms, while Fig. 6 shows a graphical representation of the links occurring between the individual words.

Among the most frequent key words are terms related to data analysis and processing (cloud computing, big data, fog computing, machine learning) and technologies enabling data collection (sensors, wireless sensor network) (Figs. 5 and 6). Issues related to data security and privacy (security, blockchain, privacy) were also commonly used. These terms also show the most links to other terms. Analysis of the most frequent key words allowed the author to identify five thematic clusters (Fig. 7, Table 6).

The first cluster (yellow) refers to IoT application areas in smart cities (e.g., waste management, environmental monitoring, parking congestion). The red cluster includes terms related to IoT architecture for smart cities. The blue and dark green clusters cover energy issues (energy management, energy efficiency) and security and privacy of IoT use in smart cities (security, privacy), respectively. The last cluster (light green) combines concepts related to data collection and processing in a smart city (e.g., big data, data mining, cloud computing, fog computing, edge computing). Data management issues are closely linked with security and privacy issues, as noted in Fig. 7.

Fig. 5. The most frequently occurring key words

Source: elaborated by the author using WordArt.

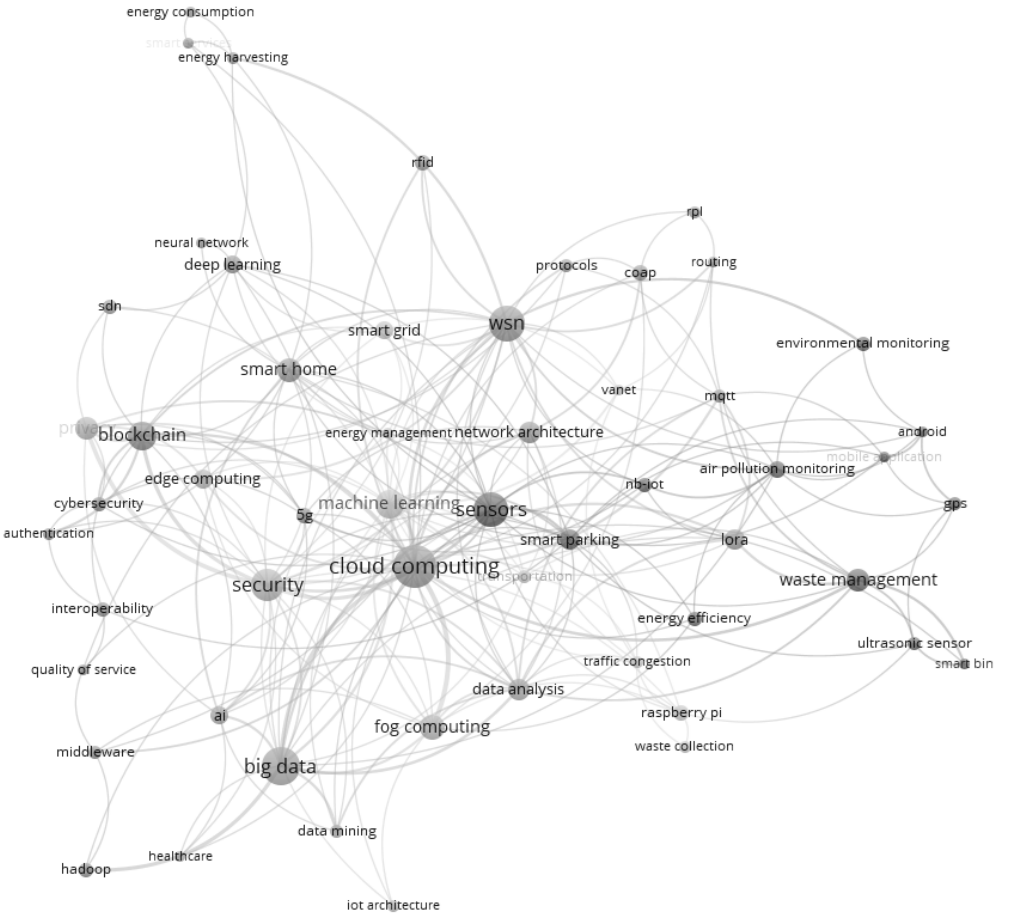

Fig. 6. Key word co-occurrence map

Source: elaborated by the author using the VOSviewer software.

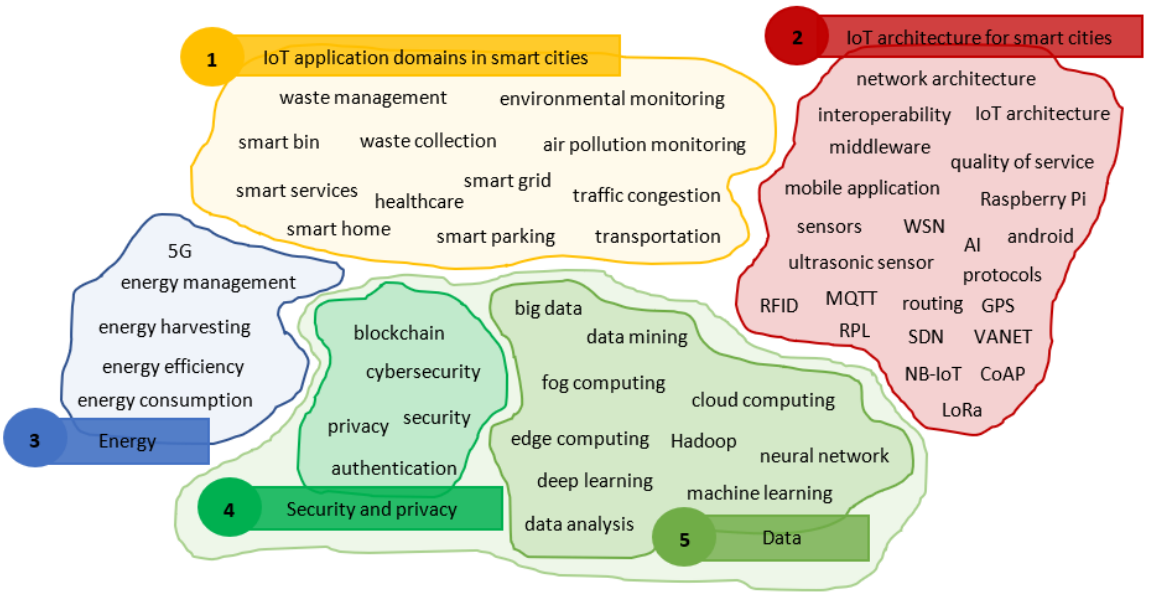

Fig. 7. Subareas of “IoT-based” smart city research

Tab. 6. Subareas of IoT-based smart city research

No.	Cluster name	Words
1.	IoT application domains in smart cities	waste management, waste collection, smart bin, environmental monitoring, air pollution monitoring, smart grid, smart services, smart home, healthcare, smart parking, traffic congestion, transportation
2.	IoT architecture for smart cities	network architecture, IoT architecture, interoperability, quality of service, middleware, routing, Raspberry Pi, sensors, ultrasonic sensor, wireless sensor network (WSN), protocols, MQTT, Vehicular Ad Hoc Network (VANET), Constrained Application Protocol (CoAP), LoRa, Routing Protocol for Low-Power and Lossy Networks (RPL), Software Defined Network (SDN), RFID, android, mobile application, Narrowband IoT (NB-IoT), GPS, artificial intelligence (AI)
3.	Energy	5G, energy management, energy harvesting, energy efficiency, energy consumption
4.	Security and privacy	blockchain, cybersecurity, security, privacy, authentication
5.	Data	big data, data mining, fog computing, cloud computing, edge computing, data analysis, machine learning, deep learning, neural network, Hadoop

4. Discussion of results

Analysis of the most frequently occurring key words allowed the identification of the five major thematic clusters. Table 7 presents the thematic threads within each of these clusters, along with examples of publications.

It can be noted (Table 7) that the first research area refers to potential application areas of the Internet of Things in smart cities. The key word analysis shows five major research trends in this area — transportation, waste management, environmental protection, smart buildings, and healthcare. Each of these subareas presents different issues analysed by the authors. The subarea one (transportation) explores such issues as traffic management (Masek et al., 2016; Rizwan et al., 2016), parking management (Gandhi, 2016; Sadhukhan, 2017), and accident management (Bhatti et al., 2019). As Masek et al. (2016) indicated, the capabilities of current traffic management systems are insufficient for future needs. Future traffic management systems should integrate current systems, manage effectively under diverse infrastructure and allow to visualise and simulate urban traffic. They should also determine traffic conditions more precisely and respond to emergencies more effectively (Masek et al., 2016). The improvement of existing systems is a frequent research area (Masek et al., 2016; Misbahuddin, 2015). Various authors also analyse elements of the traffic management process, including accident management. IoT can improve the speed and efficiency of response of automated accident detection and emergency services notification systems. An example of such a system is the Accident Detection and Reporting System (ADRS) developed by Bhatti et al. (2019). An Android smartphone (equipped with four sensors: noise, pressure, speed, and accelerometer) can be used to identify the accident site, the nearest hospital, and notification of the appropriate hospital ward. Accident information is sent when defined threshold values are exceeded (Bhatti et al., 2019). IoT can also improve the parking space management process by enabling remote monitoring of parking space availability, reservation, payment, and identification of damage-inflicting offenders or stolen vehicles (Gandhi, 2016; Sadhukhan, 2017).

Waste management is another identified subarea. It is one of the biggest challenges facing modern cities due to dynamic urbanisation, excessive consumption of goods, ineffective waste management systems and mechanisms (collection, selection, collection, disposal and recycling), and low use of modern technologies (Ali et al., 2020). Smart waste management systems are based on the use of different sensors (e.g., weight, pressure, temperature) that allow monitoring of the fill level of waste containers in real-time. The system users receive timely information about the need to empty containers, allocate resources, optimise waste collection routes and schedules, or about potential fire hazards.

The collected data enables the creation of reliable statistics and forecasts, which facilitate decision-making for city authorities (Ali et al., 2020; Anagnostopoulos et al., 2017; Sharma et al., 2020). As Sharma et al. (2020) pointed out, the main implementation barriers of intelligent waste management systems in cities are the lack of connectivity, standardisation, and legal regulations. Anagnostopoulos et al. (2017) reviewed and characterised ICT-based waste management models. According to a proposed taxonomy, the authors classified the identified models and compared them in terms of key components (physical infrastructure, software analytics and IoT technology).

Tab. 7. Main research areas and subareas in IoT-based smart cities research

No.	Research areas	Main research subareas	Selected publications
1	IoT application domains in smart cities	Transport	(Bhatti et al., 2019; Gandhi, 2016; Ji et al., 2014; Masek et al., 2016; Rizwan et al., 2016; Sadhukhan, 2017)
		Waste management	(Ali et al., 2020; Anagnostopoulos et al., 2017; Bharadwaj et al., 2016; M. Sharma et al., 2020)
		Environmental monitoring and protection	(Duangsuwan et al., 2018; Indhumathi & Dineshkumar, 2019; Malche et al., 2019; Shah & Mishra, 2016)
		Homes	(Dutta & Roy, 2017; Dwivedi et al., 2021; Hui et al., 2017)
		Healthcare	(Abril-Jiménez et al., 2020; Bryant et al., 2017; Dawood & Sah, 2021; Poongodi et al., 2021)
		Disaster prevention	(Loftis et al., 2018; Sakhardande et al., 2016; Shah et al., 2019; A. Sharma et al., 2020)
		Lightning	(Rossi et al., 2016; Sikder et al., 2018, 2018; Tambare et al., 2016; Xu & Wang, 2020)
2	IoT architecture for smart cities	IoT framework for smart city	(Abreu et al., 2017; Cerchecci et al., 2018; Ganchev et al., 2014; Gaur et al., 2015; Nitti et al., 2017)
		Green IoT	(Alsamhi et al., 2019; Kaur et al., 2018; Sarkar & Gul, 2021)
3	Energy	Energy management	(Brundu et al., 2017; Ejaz et al., 2017; Khajenasiri et al., 2017; Mahapatra et al., 2017)
4	Security and privacy	Data security and privacy	(Al-Turjman et al., 2019; Gheisari et al., 2019; Shen et al., 2019)
		Cyberattacks detection	(Alrashdi et al., 2019; Li et al., 2019; Qureshi et al., 2020; Rashid et al., 2020)
		Blockchain	(Fan et al., 2020; Gong et al., 2019; Yetis & Sahingoz, 2019)
5	Data	Data management and analysis	(Cheng et al., 2018; He et al., 2018; Mohbey, 2017; Moreno-Cano et al., 2015; Romero et al., 2016; Zahmatkesh & Al-Turjman, 2020; Zhang, 2020)

The third subarea covers the issues related to environmental monitoring and protection. The increasing number of vehicles and intensive industrial activities cause a high level of air pollution in urban areas, which is a major threat to human health (Duangsuwan et al., 2018). As indicated by Malche et al. (2019), to avoid the negative effects of environmental pollution, it is necessary to develop effective systems for monitoring and disseminating information about its status. This issue is addressed by numerous authors (Indhumathi & Dineshkumar, 2019; Orłowski et al., 2017; Shah & Mishra, 2016). The developed systems differ in terms of used methods and technologies but bring similar benefits. They allow monitoring of certain parameters in real-time, provide accurate and reliable information and signal the appearance of deviations. An example is a system proposed by Malche et al. (2019) that detects and signals elevated levels of harmful gases and noise. It consists of sensors, a microcontroller board, and a cloud-based server. As shown by the authors, in the future, it can be extended to features such as monitoring dust, water pollution levels, ultraviolet radiation, soil moisture, or detecting aerosols (Malche et al., 2019).

Smart homes are a key component of smart cities. They ensure automatic and remote control of devices and systems, which allow them to operate efficiently while reducing operating costs (Dutta & Roy, 2017). Smart homes can significantly increase the comfort of living and improve user safety through features such as remote control of parameters (e.g., temperature, light intensity), device management and control, presence detection or simulation, and identi-

fication of potential threats. They also allow adapting particular functions to the user's individual preferences. Researchers both consider the functioning of an intelligent building as an integrated system and analyse individual subsystems (e.g., burglary prevention systems or measurement systems). As Hui et al. (2017) pointed out, despite significant progress in smart home research, the rate of adoption by the public is relatively low, which is due to the lack of incentives to modernise traditional homes. The authors have identified and characterised several requirements that smart buildings must meet (including heterogeneity, extensibility, usability, self-configurable, intelligence, context-awareness, and security and privacy protection).

Smart homes are extremely important from a smart healthcare perspective. IoT improves the efficiency of traditional medical systems by ensuring the personalisation of services, remote monitoring of patient conditions, and signalling of life-threatening emergencies (Poongodi et al., 2021). Smart healthcare is also a response to issues posed by the ageing population. IoT technologies can support the elderly in daily activities, increasing their independence. They also enable real-time monitoring of health status, which affects the speed of response and effectiveness of action in the event of a health or life threat. As showed by Abril-Jiménez et al. (2020), smart city infrastructure can support preventive health care and provide personalisation of medical services by collecting behavioural data without disrupting the daily lifestyle of the elderly.

The analysis of the records allowed the author to distinguish two more frequently addressed issues — disaster management (natural and man-made) and lighting management in a smart city. The first deals with the development of complex hazard monitoring and detection systems (Shah et al., 2019) as well as systems intended for specific types of hazards (Loftis et al., 2018; Sharma et al., 2020). Natural disasters are an enormous threat to human life, the environment, infrastructure, and the economy. The use of IoT can minimise the risk of its occurrence and increase the efficiency of rescue operations (Sakhardande et al., 2016). Thus, IoT can play a key role in the emergency management process in smart cities. Gaining, processing, and providing timely and accurate data increase with the speed of response when an emergency occurs (Shah et al., 2019).

The second subarea includes smart lighting systems, which enable automatic control of indoor and outdoor lighting. IoT solutions ensure remote control of lighting installations, signalling irregularities and real-time monitoring of electricity consumption. Smart lighting systems increase the efficiency of the lighting management process, enable cities to reduce their electricity expenses, and improve the safety of residents (Rossi et al., 2016; Sikder et al., 2018; Tambare et al., 2016). An example is the self-cleaning urban streetlight system proposed by Xu and Wang (2020). A smart street lamp has sensors that allow the users to monitor specific factors (brightness, ambient temperature) and remote control of the lamp operation (Xu & Wang, 2020).

Cluster two covers issues related to the Internet of Things architecture for smart cities (Fig. 7). Cities are complex structures with their own unique identities and individual characteristics. Each city has different goals and priorities and operates in a unique environment. This means that diverse factors influence their development. Therefore, the Internet of Things architecture must meet the needs of the city. The analysis of the publication set allowed the author to distinguish two main thematic threads within this subarea. The first thread concerns general issues related to the IoT architecture. This topic was addressed, among others, by Abreu et al. (2017), who highlighted the need to ensure the reliability of communication between devices and applications. According to the authors, one of the key issues, in this case, is to ensure that the system (network and services) can be automatically restored in the case of a failure (Abreu et al., 2017). The authors in this area deal both with the design of the IoT architecture for smart cities (Abreu et al., 2017; Ganchev et al., 2014; Gaur et al., 2015) as well as with the creation of a framework for specific processes and services (Cerchecci et al., 2018; Nitti et al., 2017).

The use of the Internet of Things (IoT) in urban environments, apart from its undeniable advantages, also comes with many risks like increased consumption of energy, materials, water and chemicals, as well as production of hazardous waste. According to Kaur, Tomar and Singh (2018), the key issue is to design IoT-based systems to be environmentally friendly at all stages of their life cycle. All areas of IoT applications in smart cities (smart homes, waste management systems, transportation systems, etc.) should therefore be "green" (Kaur et al., 2018). Green IoT is a relatively new research trend in the field of IoT-based smart cities (Sarkar & Gul, 2021). A review of current research on Green IoT and potential supporting technologies was conducted by Alsamhi et al. (2019). They indicate that research focuses on "green-

ing" elements of IoT-based systems (e.g., communication, design, deployment, IoT services and application areas). According to the authors, future research directions should focus on drone technology, data transmission, M2M communication, Green IoT design, energy balancing, green Quality of Service (QoS) and security, and green big data. They identified RFID, wireless sensor networks (wsn), machine-to-machine communication (M2M), Internet, communication network, cloud computing, and data centre among the major ICT technologies to enhance Green IoT capabilities (Alsamhi et al., 2019). A proposal for a Green IoT architecture based on a cloud platform was presented by Kaur (2018), among others.

The growing number of networked devices and increasing data transfer rates result in higher energy consumption. Efficient management of energy production, distribution and consumption are, therefore, one of the biggest challenges that smart cities must face. As Ejaz et al. demonstrated, energy management in smart cities focuses on two issues — energy harvesting processes and energy-saving solutions. The first issue aims to prolong the lifetime of the equipment. The second includes scheduling optimisation, energy forecasting, and cloud-based approaches, among others (Ejaz et al., 2017). Energy issues are addressed within each of the identified research areas. The increasing demand for energy creates a need to optimise energy consumption in all areas of smart city operations (Ejaz et al., 2017).

Networked devices generate a vast amount of diverse data (big data), which poses problems for data collection, processing, selection, and analysis. As Mohbey (2017) pointed out, IoT, big data, and cloud computing are three key and interrelated components of smart cities. Data analysis also relies on the use of artificial intelligence, including self-learning systems — machine learning and deep learning, that automatically identify and remember interdependencies in analysed datasets. To meet the challenges of growing data volumes, solutions enabling data collection and processing in virtual space (cloud computing, edge computing, fog computing) are used. They allow for real-time computing, cost reduction and energy efficiency improvement.

Big data also comes with many challenges. Talebkhah et al. (2021) indicated the lack of standards, insufficient digital literacy of the population, high costs, the need to integrate disparate data, and security and privacy issues. The security of data, devices and networks is a key issue not only from the perspective of the city government but also from the residents' perspective, as it affects their openness and trust for new technologies. Among the most important security and privacy issues, Al-Turjman et al. (2019) mentioned cybersecurity, botnet activity (computers with malware), threats from the use of autonomous vehicles, and leaks of private data. As the researchers point out, the risk of threats can be eliminated or minimised using blockchain technology, cryptography, biometrics, machine learning, and data mining etc. It is also necessary to create mechanisms and regulations for security and privacy within smart systems (Al-Turjman et al., 2019). As Gheisari et al. (2019) claimed, the main drawbacks of the methods used to protect data privacy from IoT devices are the simultaneous transmission of whole data, the use of a single static privacy-preserving method for the whole system, and the lack of understanding of the context of a situation. Besides general research on systems, methods, and tools for security and privacy, authors often address the use of blockchain technology (Fan et al., 2020; Gong et al., 2019) and the prevention and detection of cyberattacks (Alrashdi et al., 2019; Qureshi et al., 2020; Rashid et al., 2020).

Conclusions

The vision of smart cities based on the Internet of Things paradigm is slowly becoming a reality. Effective implementation of the IoT paradigm in the urban environment can bring many benefits, e.g., streamline processes, facilitate decision-making, save time and minimise costs in almost all areas of human activity. However, its implementation is associated with many challenges, both of engineering and scientific nature. This publication aimed to analyse and evaluate the scientific output and identify the main research directions over the last ten years in the area of "IoT-based smart cities". Five main thematic clusters were identified — IoT application areas in smart cities, IoT architecture, energy, security and privacy, and data. These areas are closely related and intertwined. A smart city is an integrated and coherent system, providing data exchange and communication between the various components. All subsystems must be properly designed, enabling optimisation of energy consumption and guaranteeing data security and privacy. Although the smart city is based on the use of modern technologies, many authors point out that they cannot be treated as the only factor that proves the "intelligence" of cities. Technologies

should be only the tools for improving actions taken in a city. Their use is justified only if they help solve actual problems of cities and their inhabitants. However, the analysis showed that issues, such as the involvement of citizens in designing visions for the development of smart cities or the possibility of using IoT solutions to activate them, are rarely addressed in research.

An advantage of the conducted study is the integration of data from three databases (Web of Science, Scopus and IEEE Xplore), which significantly increased its scope allowing for a comparison of the results. The strictly structured methodology for the implementation of the bibliometric analysis allowed the author to obtain reliable results. It should be noted that the bibliometric analysis is a very broad method, and the choice of its methodology depends on the researcher and the type of issue analysed. The limitations of the present study result mainly from the specificity of the method used. The analysis of extensive collections of materials is associated with the possibility of the appearance in the analysed set publications that do not correspond to its purpose. In this study, the author limited the analysed set of publications to materials containing the selected key words only in the title. This increased the reliability of the study, but at the same time, it is one of its limitations since the rejected set could also contain relevant publications. Another limitation arises from the ranking by the number of publications. Authors or journals with many publications could be rarely cited. Moreover, in the case of ranking journals, authors or organisations, one publication with numerous citations may determine a high position in the ranking. Therefore, although the rankings were created based on the number of publications, the data on citations were also included. This study is preliminary, and its results may constitute the basis for further research, i.e., a systematic literature review or subsequent, separate bibliometric analyses of the areas identified in this publication.

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