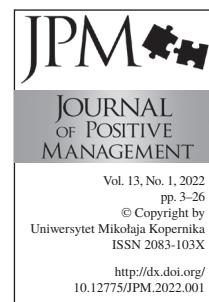# AGILE MANAGEMENT OF SUSTAINABLE DEVELOPMENT – CIRCULAR ECONOMY CONCEPT MODEL FOR FURNITURE INDUSTRY

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Abstract

Purpose: The goal of the article is to create a model whose management method will take into account individual needs (client, entrepreneur), implementing the standards of global economic sustainability. The created model allows defining the Sustainable Development Goals in terms of the environmental dimension of the circular economy.

Methodology/Approach: For article purpose, circular economy was used as a method improving the chances of achieving the goals of sustainable development. The statistical significance of the variables were checked for obtain data. In addition, this process was supported by the Deming cycle in order to be able to respond to changes using the agility methodology.

Findings: The results of the research allowed to identify the most important (SDGs), which, when combined with the trends of the industry/sector, formed a balanced loop taking into account all participants and their needs.

Implications/limitations: Managing a company according to global standards is a big challenge. The results of an analysis of own needs (an enterprise) should correlate with the needs of stakeholders in the supply chain and with the direction of development of the industry/sector in order to support the domestic economy and be competitive on global markets.

Originality/value: Study explains undertaken activities for implementing process of correlation between entities which must take into account the good of the individual and, above all, of the general public.

Keywords: sustainable development, agility, circular economy, organizational improvement.

Paper type: Research paper

1. Introduction

Building a sustainable world requires one to exceed the perspective of short-term goals. Europe 2020, the 2030 Agenda for Sustainable Development, 6 priorities of the European Commission for 2019–2024, Low-carbon economy by 2050, Recovery Plan for Europe – these are some strategic initiatives that provide an

opportunity to initiate changes. Changes implemented individually in particular countries will allow for the implementation of joint European goals. They are the first step to sustainable development on a global scale.

In line with the idea of "Think globally, act locally", the process of introducing changes can be started with support for a specific industry in a given country. Such directional solutions allow the use of an agile methodology, which continuously enables adaptation to changing conditions. National Smart Specializations (NSS) is a solution adopted in Poland as part of the Europe 2020 strategy. As part of NSS, activities are carried out on the transformation of the national economy towards an economy that efficiently uses resources (including natural resources) and activities allowing for the creation of innovative socio-economic solutions supporting this transformation. The detailed NSS list has been in force since 1 January 2021 and was published by the Ministry of Development, Labour and Technology (MDT, 2022). In their activities, smart specializations use the scientific and business potential (in the area of research, development and innovation) and cooperative relations (in the area of specialization). They also take into account the possibilities of economic development as well as market trends and niches. Thus, creating a great opportunity for the development of a specific area of the industry. NSSs can obtain support from innovation centers (MDLT, PARP, 2021), which are referred to as Business Environment Institutions (BEI). They include entities providing various types of services for the (vast majority of the) small and medium-sized enterprises (SME) sector. These include consulting, information and training services, or even provision of technical infrastructure necessary to manage a business, including financial services. The service specialization, in addition to innovation centres, includes entrepreneurship centres and non-banking centres and financial institutions. Local expansion (approached as a national expansion from the perspective of global benefits) should be strongly correlated with sustainable development. The possibilities of implementing the strategy of balanced and sustainable development included in the 2030 Agenda for Sustainable Development (United Nations, 2015), are supported by the 17 Goals Campaign (CSR Consulting, 2020). Domestic business, with the participation of a wide partnership of companies and institutions, mobilizes Polish business to inter sectoral cooperation for the 2030 Agenda. The campaign offers the opportunity to learn about the perspective of the selected industry in relation to each Sustainable Development Goal. The approach to the implementation of this strategy is significantly related to the broadly understood environmental protection and awareness regarding the protection of natural resources. The local (national) approach to the environmental aspects makes it possible to focus on the protection of resources located in the territory of the country. One way is to introduce a circular economy model. Circular economy (CE) is an economic concept which assumes that waste generation will be minimised. Products, materials or raw materials should remain in the economic cycle as long

as possible. This idea covers all stages of the product life cycle (design, production, consumption), including waste collection and further management. (Council of Ministers Republic of Poland, 2019). CE (Lembachar *et al.*, 2022) constitutes a key element of the strategy of the European Commission (EC) in the European Green Deal (GD). Its aim is to transform the EU into a fair and prosperous society with a modern, competitive and resource-efficient economy; a society in which there will be net zero greenhouse gas emissions in 2050 and where economic growth will not depend on the use of resources. The circular economy implements one of the pillars of GD – Mobilizing Industry for a Clean Circular Economy, and the new Circular Economy Action Plan for 2020–2024 (covering 35 activities for the entire lifecycle of the product). (European Union, 2021). Economic restructuring on such a large-scale requires a flexible approach to implementing change, even when all attention is focused on one industry. Caring for the environment, future social needs or economic wellbeing requires a sustainable approach to the management of the industrial sector. One of the available solutions is a business model that uses agile methods. Based on experience (agility is currently the most commonly used approach when it comes to software development (Beedle, *et al.*, 2001) which have shown improvement in quality, customer collaboration and performance in all its aspects in the development process for software engineering (Digital.ai, 2021; Schmitt and Diebold, 2016), the methodology is being adopted more and more often into other business areas, going beyond the scope of IT (Beerbaum, 2021; Böhm and Unnold, 2021). Achieving the "higher – faster – further" goal forces entrepreneurs to adapt their business processes to external conditions in a flexible, efficient and quick manner. Thus, agility can have a positive impact on business processes to achieve such things as better quality, shorter time to market, or greater customer involvement (Schmitt and Hörner, 2021).

2. Literature review

Sustainable development was defined for the first time in 1987 in the report entitled: "Our Common Future" (WCED, 1987). This definition draws attention to the way of meeting the current needs on which the fate of future generations depends as well as their ability to satisfy their own needs (Kowalik *et al.*, 2018). Another understanding of sustainable development brings it down to a centralized goal of economic growth that is socially comprehensive and environmentally sustainable (Sachs *et al.*, 2022). Defining sustainable development therefore covers a broad spectrum of human progress, resource use and business interactions (Brown *et al.*, 1987; Mieg, 2012; Strandhagen *et al.*, 2017). On the one hand, the idea of sustainable development (SD) refers to an approach involving the adoption of a development strategy with the expectations of short-term effects (sustainability-S), and on the other hand, to long-term effects (sustainable development-SD). Such a path of progress reveals concepts

(tantamount to understanding SD in the context of three pillars: economic, social and environmental (UN, 1992a; UN, 1992b; Elkington, 1998), the balance of which in terms of benefits is often enforced from entrepreneurs. The definition of environmental sustainability is identified with preserving biodiversity along with attention to economic and social interests (Miceli *et al.*, 2021). Its values can be achieved through the appropriate use of resources, including renewable ones, as well as the reduction of waste/emissions (Moldan *et al.*, 2012; Alayón *et al.*, 2017). The definition of sustainable economic development draws attention to the profitable dimension of the implementation of the social and environmental areas. Economic values are seen as a consequence of organizational resilience (long-term company results and their growth) (Cardoni *et al.*, 2020; Cancino *et al.*, 2018). In turn, social sustainability binds and stabilises the population. Social development as well as the prosperity generated by the company are the measures of its value (Eizenberg *et al.*, 2017; Shou *et al.*, 2019). Sustainability has become the focal point of any activity, so integral access to resources by each group of participants of SD is important. Completely-inclusive approach (Shaker and Zubalsky, 2015) for analysing purposes, SD is used in smaller geographical areas, e.g. a region. Its key element is co-benefit or trade-off among the SDGs which is characterized by its high contextual integration. This allows the pillars to be combined as well as the 17 Sustainable Development Goals (SDGs) (Reid *et al.*, 2017; Mohamad Taghvaee *et al.*, 2021). SDGs represent a common vision of the human future, which is just, safe and sustainable. SD goals have a global impact, and all countries are responsible for their implementation, regardless of the dominant sector of the economy (Sachs, 2021). Enterprises gradually began to unite to achieve these goals. As a result, they became a 'dominant social institution' (Crane and Seitanidi, 2014) increasing their involvement in economic, social and environmental matters. Despite the benefits of implementing SDGs, the goals need to change in each country. Both at the level of accountability by the government, businesses and, above all, consumers. Such an undertaking requires effort from all market players. Activities should focus on measuring and monitoring the progress in the implementation of changes resulting from achieving the SDGs (Šnircová *et al.*, 2016; Ordonez-Ponce *et al.*, 2021).

The circular economy philosophy is a set of guidelines in the context of sustainable development. Its importance is growing stronger in terms of supporting the transformation of the industry in the SD process (Stewart and Niero, 2018). Various economic areas are described in the literature, using or adopting the CE definition. Approached form the perspective of building the environmental sector, (Geissdoerfer *et al.*, 2017) recommends a gradual approach to achieving sustainability, as CE is a precondition for sustainable development. Inspiration drawn from nature is equal to not wasting it, where all output products are inputs to another process (Mhatre *et al.*, 2021). This strategy is the opposite of the

traditional open system. It aims to recycle waste and to create access to resources to ultimately bring economic and valuable benefits (Homrich *et al.*, 2018). CE as an SD strategy displaces the linear economic system. It is treated as a new paradigm, which indicates the need to reorganize the actions taking place between the human business activity and the environment in which it carries out its activity (Mattos *et al.*, 2018). Business organizations are a part of the comprehensive CE system and the decisions they make, having consequences in economic development, should balance the other pillars of the SD. The potential of CE in the context of SDGs allows to apply circular strategy in which unused resources can be used to deliver value. CE also promotes care for the environment, not treating it as a trash can (Kristoffersen *et al.*, 2020). According to the definition of the Polish Ministry of Climate and Environment (MCE, 2022) "circular economy is a concept aimed at the rational use of resources and limiting the negative environmental impact of manufactured products, which – like materials and raw materials – should remain in the economy for as long as possible, and the generation of waste should be minimised to the maximum extent possible". CE in terms of economic and micro environment is described quite extensively in the literature (Urbinati *et al.*, 2017; Aranda-Usón *et al.*, 2019; Scarpellini *et al.*, 2020). The method of implementing CE models in an enterprise is interesting from the local or regional point of view.

Innovative business models are tools for fundamental change in the way business is conducted, aimed at its sustainability (Bocken *et al.*, 2016; Fehrer and Wieland, 2021). These models describe the organization as creating value for its stakeholders, taking into account the exemplary structure of linking activities and ways of managing the activities through:

1) Efficient material-technical loops: Circular supply chains and Supply chain management (Leising *et al.*, 2018; Esposito *et al.*, 2018);
2) Effective product-service loops: Service solutions, Service management item (Hobson *et al.*, 2018; Tukker, 2015);
3) Social-collaborative loops: Network integration and Platform orchestration (Todeschini *et al.*, 2017);
4) Symbiotic ecosystems: collaborative networks and Collective entrepreneurship (Stål and Corvellec, 2018).

Stakeholders who are assigned specific roles are an important link in models in the circular ecosystem and their effective inter-organizational relations are the basis for the above (Zucchella and Previtali, 2018; Lieder and Rashid, 2016; Ranta *et al.*, 2018; Stewart and Niero, 2018). The supply chain redefines it, where many stakeholders make decisions according to a complex system. The increasing level of awareness, along with global concern regarding the aspects of sustainable environmental development, creates new Circular Supply Chains (CSC) (Gou *et al.*, 2018). Their idea involves the promotion of closed processes in the chain, sustainable development, the zero waste concept as well as regeneration of the

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chain itself (Mesjasz-Lech, 2021; Klimecka-Tatar *et al.*, 2021). Additionally, effective implementation of CE principles in the supply chain requires a lot of knowledge and skills. Breakthrough technologies, and above all digitization of industry (implemented under the concept of the fourth industrial revolution), affect strategic and operational decision-making (Osinska and Zalewski, 2020). Research on the influence of the Internet of Things, big data or even artificial intelligence shows that they change the way companies operate, which is reflected in solutions focusing on the optimizing the circular supply chain (Muller *et al.*, 2018; Gammelgaard, 2019; Scuotto *et al.*, 2020).

The capacity of a circular supply chain (CSC) is an important element when it comes to understanding its relationship with the circular economy supply chain management (SCM). The introduction of CE assumptions to the supply chain management model requires enterprises to redesign their production and supply processes as well as reorganize logistics, sales and information management systems (van Capelleveen, 2021). The circular supply chain (as a combination of the CE and SCM concepts) includes the design of the CSC itself and its relationship management. Very often the, the implementation of CSC alone, requires changes in the approach to project management. An example is the use of 'agile energy systems' (Clark II, 2004, 2007), which adapt to changes in a flexible and effective way in order to achieve economic, environmental and social benefits. Zeng *et al.*, 2017, note that circular economy supply chain management practices (especially design and relationship management practices) can have a positive impact on business results, further translating into a sustainable competitive advantage.

Agile methodology (AM) in project management is focused on flexibility. The transition from the traditional approach to agile project management changes the role of project managers to a moderator who coordinates the work of the team so that joint activities reflect the final decisions. (Floricel *et al.*, 2016). Such actions cause four main agility values to be fulfilled. They demonstrate the superiority of the individual (interaction) over processes and tools; usability over documentation; cooperation with the client beyond the contract and response to changes beyond the plan. The concept of agility can be defined as the ability of enterprises to detect changes so that it is possible to reconfigure resources, processes and strategies (Garcia *et al.*, 2021). Agility is an approach that focuses on efficiently working people and efficiently used technologies, so that by working with clients it is possible to adjust the business model to their changing needs (Geyi *et al.*, 2020; Haffer, 2017). Agile is also used as a supply chain strategy. It makes it possible to satisfy customization which is so crucial in product development and service delivery in a globally competitive environment. The supply chain strategy based on agility makes it possible to use market knowledge to maintain an advantage in an unstable market and increase inter-organizational competitiveness (through cooperation) (Meyer *et al.*, 2017; Ambe, 2010; Çağlar Kalkan and

Aydın, 2020). The development and concepts of new/innovative business models (including AM solutions) make it possible to achieve SDGs while strengthening their environmental/climatic dimension in the circular economy.

3. Research methodology

The research process focused on three main areas: sustainable development, agile project management methodologies and the circular economy, as well as one economic area: the furniture industry. Selected SDGs were analysed, which described the model of city urbanization as a trend defining a selected industry. By checking the statistical significance of the variables, the ones with the highest influence on the described variable were found. Subsequently, a methodology for project management of the furniture production process was proposed in accordance with the assumptions of the agile methods, and then a closed circuit for the selected industry was characterized. Everything constitutes the CE process, which complemented by creating the possibility of a flexible approach to changes (implementation of trends and the SDGs degree) – agile and continuous improvement – the PDCA (Deming cycle: Plan, Do, Check, Act).

Tools for statistical analysis were used in the quantitative research. A correlation and regression study was used to verify global indicators that define the degree of implementation of the sustainable development goals. Models describing city urbanization as a dominant trend in the furniture industry were analysed. An integrated programming environment for the R language (RStudio) was used to perform calculations and data presentation.

Data for quantitative analysis was obtained from the Central Statistical Office in Poland, using the Local Data Bank tool and the National Reporting Platform (SDG). Qualitative analysis data is published by the Polish Agency for Enterprise Development. Due to the varied process of data publication, the time range covered the following periods: 2010-2019 (quantitative); 2017-2030 (qualitative). The subject of the study is the territory of Poland and the furniture industry.

4. Results – model establishing

Creating the model assumes linking three main areas of activity that are SD, Agile Management and Circular Economy. The next stage is a brief presentation this activities as fundamental elements building the concept of the model.

Sustainable development covers many challenges, the implementation of which depends on the cooperation of many countries, so that the implementation of individual goals brings global benefits. Defining the goals dedicated to a specific industry is a proposal to solve the problem of identifying the needs of the three pillars of sustainable development.

Building a sector/industry based on the concept of sustainable development, especially one related to natural resources, requires the use of a flexible business

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model. It is important to constantly introduce changes to maintain a balance between the demand/supply for a product and the consumption of raw materials for their production without disturbing their ecosystem. Currently, in times of the fourth industrial revolution (and preparing for the fifth one), having knowledge and skills is the key to the development of industry. Building innovative working teams based on the experience gained "along the way", i.e. Complex Adaptive Systems (often used in the software development process), makes it possible to respond to changes and adapt to the situation. Agile methodologies are a response to the need for changes. The Agile Manifesto, ultimately created for the needs of the IT industry, is the basis for assessing the flexibility of the declarations written in four points and the twelve principles (Beedle *et al.*, 2001 behind it (i.e., agile software).

Circular economy is an economy that aims rational use of resources. Activities aimed at environmental protection, with particular emphasis on improving the climate, should be a priority in the development objectives of all countries in the world. Building the country's economy broken down into industries that will be able to propose global but directional pro-ecological solutions is a proposal to implement CE in practice.

4.1. Sustainable Development Goals (SDGs)

The 2030 Agenda for Sustainable Development, including the Sustainable Development Goals, was adopted by all 193 UN member states under the Resolution of the General Assembly on 25 September 2015 in New York (UN, 2015) 8 out of 17 goals were used for research regarding the furniture industry in Poland. Their description and characteristics are presented in Table 1. The goals were compared with market trends that affect the development of the furniture industry in Poland according to the Polish Agency for Enterprise Development in Poland (PARPa).

Table 1. List of global indicators for Poland (SDGs) supplemented with national data (Central Statistical Office in Poland) with trends for the furniture industry in Poland

Source: (PARPb), (BDL)

SDG	Global indicator	Trend
Goal 1. End of poverty (G1)	X_1: Poverty rate after social transfers (total for city/village) [%]	Society (T8)
	X_2: Share of people receiving unemployment benefits in the total number of unemployed [%]	
Goal 3. Good health and quality of life (G3)	X_{3-4}: Deaths due to cancer and chronic respiratory disease per 100,000 population [persons]	Health (T7)
	X_5: Birth rate among young women (women aged 15-19) [persons]	Family (T4)
	X_{6-8}: Live births by single age groups of the mother (women aged 20-30, 31-40, 41-50 and more) [million people]	

SDG	Global indicator	Trend
Goal 4. Good quality of education (G4)	X_9: Participation rate in organized education (one year before the start of compulsory education) [%]	Education (T5)
	X_{10-12}: Enrolment rates (primary and secondary education: vocational and general vocational schools, post-secondary schools) [%]	
	X_{13}: University graduates per 10 thousand [person]	
	X_{14}: Passing final secondary school exams [%]	
Goal 8. Economic growth and decent work (G8)	X_{15}: Median dynamics of sold production of the furniture industry [%]	Consumerism (T3)
	X_{16}: Domestic Material Consumption (DMC) [tons]	
	X_{17}: Percentage of tourism in GDP [%]	Society (T8)
	X_{18}: Young people not working, not learning and not acquiring additional education [%]	Population (T1)
	X_{19-21}: Share of the population by economic age groups in% of the total population (in pre-working, working and post-working age) [%]	
Goal 9. Industry, Innovation, Infrastructure (G9)	X_{22-24}: Passenger transport sizes by type (rail, road, air [million passengers])	Infrastructure and connectivity (T6)
	X_{25-27}: Freight transport sizes by type (rail, road [million tonnes], air) [thousand tons]	
	X_{28-29}: Housing construction – indicators (completed dwellings per 1000 population [absolute number]; usable floor area of completed dwellings per 1000 poeple [m^2])	Real Estate (T2)
	X_{30-31}: Housing resources – indicators (dwellings per 1000 inhabitants [absolute number]; average usable floor area of 1 dwelling [m^2])	
Goal 10. Less inequalities (G10)	X_{32-33}: Average annual growth rate of net disposable income per person in a household (in total and the 1st and 2nd quintile groups with the lowest income – lower range 40% of the population) [%]	Society (T8)
	X_{34}: Marriages per 1,000 people [absolute number]	Family (T4)
Goal 15. Life on land (G15)	X_{35}: Share of forest land in the country's land area [%]	Natural resources (T9)
	X_{36}: Progress towards sustainable forest management [%]	
Goal 17. Partnerships for the goals (G17)	X_{37}: Number of subscribers to fixed broadband Internet per 100 inhabitants (over 100 Mb/s) [persons]	Infrastructure and connectivity (T6)
	X_{38}: Macroeconomic matrix (price dynamics [PLN] of consumer goods and services) [%]	Consumerism (T3)

Table 1. continued

The study of linear models on the basis of the data in Table 1 was carried out broken down into individual SDGs. The variables showing a statistical significant impact on the model describing urbanization (the dominant trend in the furniture industry) are characterized in Table 2. In order to describe them, the division into two groups of the significance level was used. The first model: SDGs≤1%, refers to the explanatory variables whose estimates are affected by an error ranging from 0% to 0.1%. The second model: SDGs≤10%, refers to the error of estimation above 0.1% but not more than 10%.
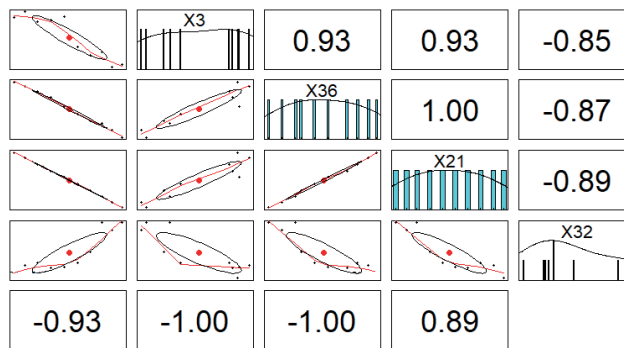
Significance codes	Coefficients	Estimate	Pr(>|t|)	Goal / Trend	Statistics for the model trend
(0-0.001]	X_3	-16.729	0.000239	G3 / T7	Multiple R-squared: 0.8723 F-statistic: 23.91 on 2 and 7 DF p-value: 0.0007444
	X_{36}	-123.97	9.69e-05	G15 / T9	Multiple R-squared: 0.9952 F-statistic: 720.7 on 2 and 7 DF p-value: 7.846e-09
(0.001-0.01]	X_{21}	-72.471	0.00123	G8 / T1	Multiple R-squared: 1 F-statistic: 3.908e+04 on 4 and 5 DF p-value: 2.025e-11
	X_{32}	58.824	0.00109	G10 / T8	Multiple R-squared: 0.991 F-statistic: 87.66 on 5 and 4 DF p-value: 0.0003546
(0.01-0.05]	X_{18}	7.296	0.01456	G8 / T1	Multiple R-squared: 1 F-statistic: 3.908e+04 on 4 and 5 DF p-value: 2.025e-11
	X_{19}	34.410	0.02020		
	X_{30}	-9.7200	0.0461	G9 / T2	Multiple R-squared: 0.9986 F-statistic: 894.8 on 4 and 5 DF p-value: 2.542e-07
	X_1	49.235	0.01186	G1 / T8	Multiple R-squared: 0.991 F-statistic: 87.66 on 5 and 4 DF p-value: 0.0003546
	X_2	-60.223	0.01479		
(0.05-0.1]	X_{38}	108.76	0.0944	G17 / T3	Multiple R-squared: 0.4124 F-statistic: 1.404 on 3 and 6 DF p-value: 0.3303
	X_7	-54.10	0.0533	G3 / T4	Multiple R-squared: 0.9951 F-statistic: 163.2 on 5 and 4 DF p-value: 0.0001036
	X_{11}	-92.6187	0.083652	G4 / T5	Multiple R-squared: 0.9798 F-statistic: 24.25 on 6 and 3 DF p-value: 0.01226

Table 2. A list of the most statistically significant global indicators grouped according to trends for the furniture industry in Poland

Source: own study.

The model (SDGs≤1%), in which the explanatory variables (SDGs with the highest statistical significance) are burdened with a maximum error of 1%, is as follows:

$$y_{[SDGs;\ 1]} = -0.19X_3 + 3.00X_{36} - 103.96X_{21} - 2.62X_{32} + 24879.46 \quad (1)$$

Model explaining city urbanization (Annual Urban Population at Mid-Year in Poland [thousands]) shows a very high coefficient of determination and a very good match of the variables to the model (0.9997 and 0.9995 respectively). The correlation of variables (Figure 1) shows the high degree of dependence between the variables. Variable X_{21} influences the model in the most statistically significant way (max 0.1% error of estimate).

The model (SDGs≤10%), in which the explanatory variables (SDG of statistical significance) are burdened with a maximum error of estimation in ranging from 1% ≥10%, is as follows:

$$y_{[SDGs;\ 10]} = 18.24X_{18} + 97.26X_{19} - 10.15X_{30} + 2.43X_1 + 0.72X_2 - 1.13X_{38} + 11.88X_7 - 18.49X_{11} + 25349.38 \quad (2)$$

This model (Y- city urbanization: Annual Urban Population at Mid-Year in Poland [thousands]) presents a very high coefficient of determination and a very good match of the variables to the model (1.0 and 0.9998, respectively). The correlation of variables (Figure 2) presents the high degree of dependence between the variables. Variable X_{30} it influences the model in the most statistically significant way (max 5% error of estimate).

The analysis of the above models allows to build an optimal linear model for variables describing city urbanization in Poland. The model examining the relationships between the most statistically significant explanatory variables has the following form:

Figure 2.
Relationship
analysis for the
SDGS≤10% model:
dependent variable
Y and statistically
significant
explanatory
variables (X_1, X_2,
X_7, X_{11}, X_{18}, X_{19},
X_{30}, X_{38})
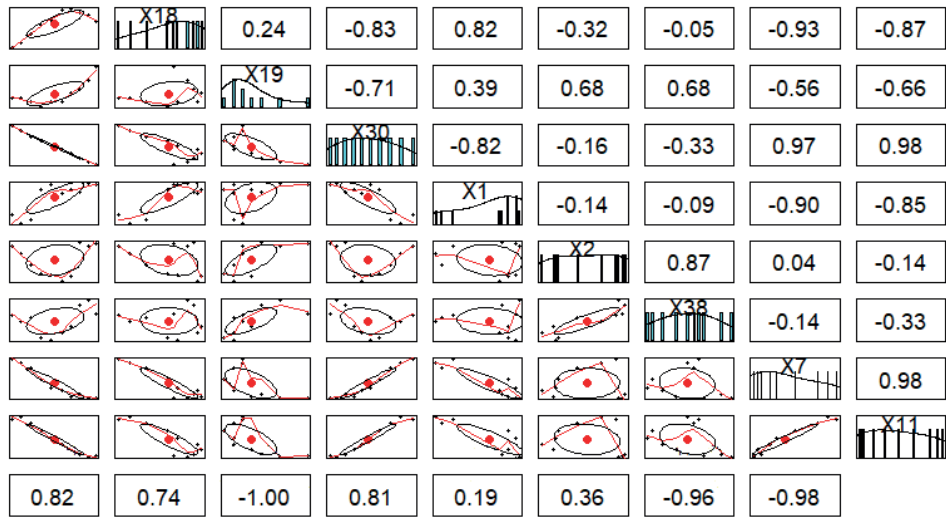
Source: own study.

$$y[_{SDGs}] = -84.104X_{21} - 2.226X_{30} + 25531.237 \quad (3)$$
$$(9.874) \qquad (1.431) \qquad (333.991)$$

Assuming an increase of 1% in the share of the post-working age population in% of the total population and no change in housing resources, it is expected that the annual urban population in Poland will decrease by 84 thousand. On the other hand, assuming that the housing resources will increase by 1 flat per 1000 inhabitants and the share of the post-working age population will not change, the average annual urban population in Poland will decrease by 2 thousand. Fluctuations for the sample in the case of redrawing data for the model are less than 10% of the population and 1.4 of a flat, respectively. The model is characterized by a high coefficient of determination and data matching (Multiple R-squared: 0.9996, Adjusted R-squared: 0.9995).

The list of variables (statistical significance of the impact on models) broken down by goals and trends indicates that the most important aspect or the furniture industry (the approach of urbanization as a dependent shaping this industry) is as follows:

1) Goal:
- Economic Growth and Decent Work (G8: X_{21}, X_{18}, X_{19});
- Ending poverty (G1: X_1, X_2);
- Good health and quality of life (G3: X_3, X_7).
2) Trend:
- Population (T1: X_{21}, X_{18}, X_{19});
- Society (T8: X_{32}, X_1, X_2).

When comparing the above data with the concept of sustainable development, one can notice the dominant social aspect over the economic and environmental one. Additionally, one can notice the multiplication of factors (variables: X_{21}, X_{18}, X_{19}, X_1, X_2) in the SDG and trends category. This proves their great impact on the urbanization process and the furniture industry in Poland.

4.2. Agile

Building a model enabling agile management of the sustainable development of the furniture industry in Poland required the identification of variables as the first step. The research carried out earlier (point 3.1) showed that the post-working age population and housing resources have the greatest impact on the industry. Therefore, companies producing furniture should implement such a development strategy that the design teams working on the product could adapt it to the currently changing market needs.

Features characterizing the construction of an agile business model (ABM) based on data from the optimal linear model (ySDGs) and industry market trends:

According to the Manifesto for Agile Software Development declaration (AMd):

1) "Individuals and interactions": a consumer's need: people in many retirement homes living alone in an apartment (furniture should be functional and relatively cheap);

2) "Working software": Multifunctionality: due to the small living space, the product is to fulfil many functions (one piece of furniture should enable the performance of several tasks);

3) "Customer collaboration": Acceptance: due to age-related limitations, the design of the product makes it possible to choose solutions tailored to certain needs (the furniture is easy and intuitive to use);

4) "Responding to change": Customization: the production stage is preceded by a virtual presentation of the product, which allows for its change (at the design stage, you can change the colour or texture of the furniture material, etc.);

According to the Twelve Principles of Agile Software rules (AMp):

1) "Our highest priority is to satisfy the customer through early and continuous delivery of valuable software": the purchased furniture should fulfil its function, i.e. meet the requirements of customers;

2) "Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage": furniture designing stage finished = possibility of introducing changes (customization);

3) "Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale": each subsequent

stage of the furniture making process depends on the previous one (project → visualization/prototype → production → sales);

4) "Business people and developers must work together daily throughout the project": cooperation in a team (designer, manufacturer, seller) is a precondition to eliminate problems in individual links in the furniture making process;

5) "Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done": each participant in a team is responsible for their stage of the furniture making process;

6) "The most efficient and effective method of conveying information to and within a development team is face-to-face conversation": each stage of the furniture making process is consulted with the consumer (project: acceptance → visualization/prototype: acceptance → production: acceptance =sales);

7) "Working software is the primary measure of progress": the visualization/ prototype stage is treated as a test that checks the functionality of the furniture by a potential user;

8) "Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely": optimal pace of work of each link in the team – controlling the continuity of the furniture making process;

9) "Continuous attention to technical excellence and good design enhances agility": customization of furniture excludes its universalism; with subsequent projects the universalism of furniture design can be maintained; a new approach to individualism in furniture design;

10) "Simplicity – the art of maximizing the amount of work not done – is essential": furniture design should fulfil several functions, but not require complicated maintenance;

11) "The best architectures, requirements, and designs emerge from self-organizing teams": the work system developed independently by a team is the most effective form of creative and efficient work;

12) "At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behaviour accordingly": the increase in efficiency is achieved by eliminating errors in the production acceptance stage that did not end with selling the furniture.

4.3. Circular economy (CE)

The concept of circular economy in accordance with the results of the conducted research is presented in Figure 3.
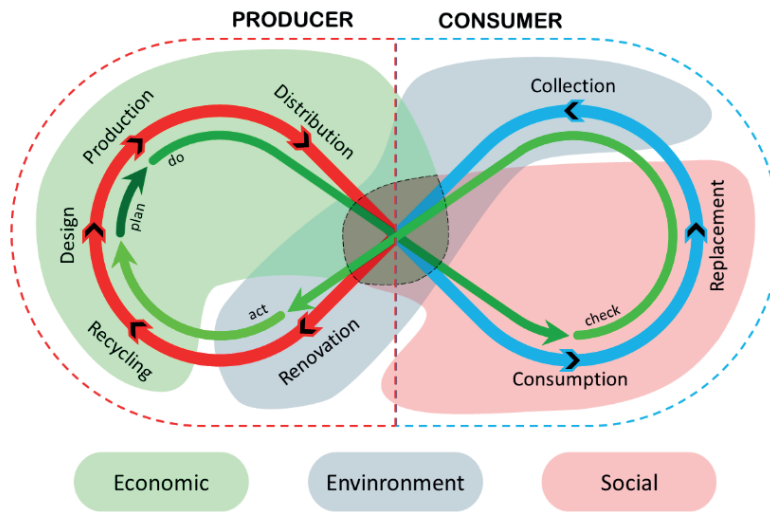
Figure 3. CE
concept – the
furniture industry
market

Source: Own study.

The CE loop process has been enhanced with:
- The concept of quality management (PDCA) as a method ensuring continuous improvement of CE;
- Agile business model (ABM) assumptions;
- The main assumptions of sustainable development in the context of the statistical significance of the SDGs;
- Characteristics of market trends in the furniture industry from the perspective of the manufacturer and the consumer.

The diagram of building a circular economy for the furniture industry in Poland is presented in Table 3.

ABM	PDCA	CE	SDGs	Trends
AMd AMp	plan	design	economic – G8	producer – T1
	do	production		
		distribution		
	check	consumption	social – G1	consumer – T8
		replacement		
		collection	environment – G3	
	act	renovation /waste removal /biosphere		producer – T1
		recycling	economic – G8	

Table 3. CE
diagram for the
furniture industry in
Poland

Source: Own study.

The CE process proposed for the furniture industry markets based on the example of Polish economy starts at the point of building a furniture design team. The implementation of an agile business model in an enterprise (or, for example, a group of enterprises cooperating within network systems – clusters), increases the possibilities of project management in a flexible manner. This way of project management fits into the PDCA cycle, creating room for improving CE. The PDCA cycle itself supports CE in its subsequent stages, to enable furniture manufacturers to constantly improve their manufacturing processes. The beginning of the CE process can be identified equally with the management of a sustainable supply chain (from furniture design to delivery to the customer). It is important from the point of view of sustainable development to combine the production stage with the biosphere in CE. Cooperation of enterprises with the B+D sector regarding solutions enabling the use of waste from furniture production to product biofuels is a key element in environmental protection and ensures 100% use of natural raw materials. Subsequent stages should be closely correlated to the CE assumptions, namely minimising waste (biosphere) and using raw materials for as long as possible. The 'replacement' phase makes it possible to supplement the furniture collection with new modules and/or replace a furniture component (e.g. front, handle, foot, hinges, rails, guides) or/and repair damage (e.g. gluing, laminating, painting). The stage of 'collection' relates to furniture, the changes of which cannot be implemented in the previous point. Their separate collection allows for their 'recycling' in the form of complete renovation or their removal. These activities should be eco-friendly. The last step of PDCA should be closely correlated with the final phases of CE. It is important that scientific works refer to the improvement of the furniture production process in such a way that its eco-friendly redistribution is possible.

According to the research analysis, the SDGs make it possible to identify 'economic growth and decent work', 'ending poverty' and 'good health and quality of life' as overarching goals in managing sustainable development in the furniture industry. These goals are appropriately assigned to economic, social and environmental development. Economic growth depends on the 'post-working age population' – that is, the buyer who is often supported by the 'pre-working age population' and/or 'unemployed and not in education' – that is, purchasing advice. The lifestyle depends on the 'poverty level' and the receipt of 'unemployment benefits'. In turn, the quality of life is built on the basis of the mother's motherhood at the age of 31-40 and the health condition associated with deaths caused by cancer.

Achievement of goals should depend on trends (the research conducted confirms that there is a repeatability of statistically significant variables in the area of goals and trends for the furniture industry in Poland). This is because they makes it possible to meet the needs of consumers and thus support the economy.

Research indicates population and society trends as the most common ones in the context of SDGs. Both are dependent on each other, because age and the related financial capacity of the population generate the status of the society. Thus, they create their consumption possibilities. Market trends for the furniture industry in the context of CE can be divided into two areas: producer and consumer. Their needs (trends) generate activities (social responsibility) that should achieve the SDGs and the assumptions of CE.

In the production process, the manufacturer should take into account the trends (based on the analysis of the conducted research) that characterize the aging society and the alpha and Z generation. The first group is described through the perspective of: less savings, more diseases and ailments, an aging workforce and thus a decline productivity, less economic growth which results in less investment, changing needs and expectations. The second generation covers consumers of digital content. The trend for Millennials (generation "Y" and generation "Z") is defined as a generation of digital natives, seeking their own style and immediate delivery/result of their actions. The trend for alpha is social media and the massive use of mobile technologies and touch interfaces (including artificial intelligence) (Stunża, 2016).

Consumers should be aware that their behaviour/actions/choices should create an attitude of social responsibility. The market trends for the furniture industry include:

1) The impact of marketing channels (PARPb).
- Recommendations from friends/family (62%);
- Loyalty programs (50.5%);
- Independent consumer reviews (49.5%);
- TV advertising (45%);
- Friends' posts on social media (43%);
- Point of sale advertising (41%).
2) Shopping method (PARPb).
- Showrooming: visiting the seller's website (42.7%), visiting the seller's physical shop (26.7%);
- Offline search for feedback: talking to family or friends about a product (39.8%);
- Online opinion seekers: reading users' opinions about a product on the website of the shop where the final purchase was made (14%).
3) Leading social media platforms (Kemp, 2021):
- Facebook (2740 million users);
- YouTube (2219 million users);
- Whatsapp (2000 million users);
- FB Messenger (1300 million users);
- Instagram (1221 million users);

- Weixin/Wechat (1213 million users);
- TikTok (689 million users).

Global consumer trends in the furniture industry boil down to the use of augmented reality when furnishing apartments and "mass" personalization (understood as I-Designer or involving the customer in the process of obtaining a personalized product).

5. Discussion

Building a circular economy requires combining many interdependent elements. The implementation of the SDGs necessary to be met by UN member states, prompts them to carry out many different activities. The results of the research carried out show one of the possible paths. The concept proposed in the article encourages the development of a circular economy, treating sectors of the economy (industries) as individual loops. Understanding the needs of the industry makes it possible to act locally, but the consequences will be global (general for the economy). Precisely targeted solutions make it possible to implement innovative activities. The proposed support for an agile approach to the design of the furniture production process (agile business model) makes it possible to take into account the improvements that will result from the Deming cycle. He supports CE, which forces solutions that ensure space for scientific research in the use of natural resources and the processing of finished products (recycling). All solutions can be freely implemented (ABM) every time the CE loop begins. Each subsequent loop is a continuation of each previous one, but it is improved (PDCA) with the results achieved. The proposed scheme of activities also takes into account the participants of the process. The changes do not have to, and even should not, only focus on achieving the SDGs. Bringing CE to the industry level in the article made it possible to specify the goals of sustainable development, important for contractors in the process of creating furniture. Consumer trends and their shopping possibilities create a direction for producers in terms of the supply. They allow to meet the entire demand without exposing entrepreneurs to potential losses, e.g. in the form of inventories (furniture customization). In addition, the supply does not exceed the demand, it supports eco-friendly activities in the field of unnecessary use of natural resources and creates responsible consumerism (reduces overconsumption).

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