Forecasting the Quality of Life in a Future Smart Society, the Case of Switzerland

Mohammad Aldabbas, Stephanie Teufel, Bernd Teufel, and Janick Spycher

***Abstract*—The rapid changes and development of technology are always bringing social challenges to societies and human daily life. The industrial revolution changed the face of the earth in an unprecedented way. Likewise does the emergence of Society 5.0. This study investigates the impact of technology of the future smart society on the quality of life taking Switzerland as an example with keeping an eye on the opportunity-risk analysis. Five measurable variables were defined to run the forecast. The outcomes predict slight improvement of the financial situation in the society collectively, but it is accompanied with job shortage in some sectors. The study and results presented in this paper are part of an ongoing comprehensive research project on Smart Sovereignty in a forthcoming smart society.**

***Index Terms*—Forecast, AR model, regression analysis, quality of life, smart society, society 5.0 (S5.0), Switzerland.**

I. Introduction: Society Change and Future Challenges

The world is on the verge of entering Society 5.0 which is a vision of a new smart society that encompasses the efforts to bring about that society [1]. Society 5.0 is positioned after the first four societies: (1.0) hunter/gatherer society, (2.0) pastoral/agrarian society, (3.0) industrial society, and (4.0) information society [2]–[4], and represents a smart and sustainable society which is based on advanced technologies that focus on many small details to point out the needs of every person in the society and provide all the tools and services for people who need them, at the time they are needed and in the right amount regardless of their ethnicity, religion, language and so forth [5]. Fig. 1 shows the development of human societies throughout history.

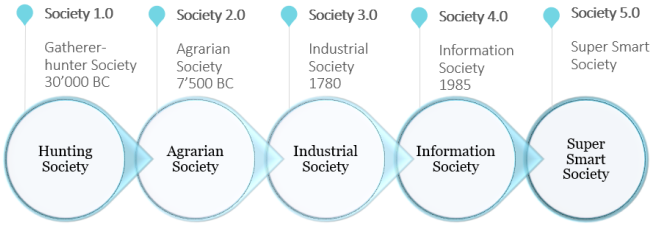

Fig. 1. Human Societies.

Society 5.0 is built on digital infrastructures, platforms, and services. They are based on smart technologies such as Artificial Intelligence (AI), robotics, Internet of Things (IoT), and blockchain, but also augmented and virtual reality or robotic process automation. These technologies have now reached a level of maturity that enables great social and economic upheavals [6]. The key to the realization of Society 5.0 is the combination of cyberspace and the real physical world to create quality data, and consequently, build new principles and resolutions to undertake challenges [7]. Once people can enjoy and live life to the fullest, then it is possible to say that Society 5.0 has achieved its objectives as an effective socio-technical system [8]. Economic growth and technological development have to exist for that purpose, and not for the prosperity of a select few [9]. Japan is the first country to lead the transformation to Society 5.0 [3], the Super Smart Society. This transformation to Society 5.0 is moved by the restriction of resources and above all human resources [10].

Even though Society 5.0 starts in Japan, its objective is not limited to a geographical territory. Society 5.0 is the future prosperity of the world [7]. The structures and insights created here will undoubtedly contribute to the resolution of societal disputes, also with regard to the future challenges facing Switzerland.

The world today is facing a great tide of change. The trend of digital transformation is unstoppable and drastically changes many aspects of society in different areas, e.g., public administration, industrial structure, employment, and private life [11]. In this new era, globalization, and the rapid evolution of digital technologies such as IoT, AI, big data analytics, and robotics, e.g., next-generation robots (NGR's) are bringing significant changes to society [4, 12, 13]. The environment and people's values are becoming increasingly diverse and complex [7, 14]. The transition to Society 5.0 offers a large number of opportunities for improving the situation of a society [4], [5], [11]. Innovations in science and technology, such as the dramatic increase in computing power, are contributing to improvements in business and society [5]. However, the transition to Society 5.0 also presents some challenges of global proportions, such as natural resource depletion, global warming, growing economic inequality, and terrorism [2], [5], [7].

We now live in a challenging age of uncertainty and growing complexity at all levels. Therefore, ICT must be fully exploited to gain new insights and create new value by establishing connections between "people and things" and between the "real world and the cyber world" (cyber-physical-social systems) to solve problems effectively and efficiently in society, create a better life for people, and sustain healthy economic growth [5], [12], [15]. This raises the question of

Manuscript received June 28, 2021; revised December 24, 2021. This work was funded by the Canton of Fribourg, Switzerland, through the smartlivinglab project at the University of Fribourg.

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doi: 10.18178/ijssh.2022.12.2.1075

How to ensure that a Society 5.0 emerges that adheres to the principles of digital ethics and security while contributing to sustainable development from which all members of society can benefit.

The world is increasingly being faced with global scale challenges, such as the depletion of natural resources, global warming, increased occurrence of natural disasters, growing economic disparity, growing unemployment in some sectors, lack of skilled workers in others, security frauds, terrorism, etc. [16]. Humanity is in a challenging age with an increasing amount of uncertainty and growing complexity at all levels [7]. Therefore, it is a critical aspect to leverage ICT and completely benefit its tools. When talking about challenges and difficulties for the future Society 5.0, it is essential to keep in mind that a super-smart society is a socio-technical system [8]. This implies that it is not sufficient to take exclusively technical aspects into account, but social characteristics also need to be considered as well [2]. In the transition to and after the achievement of Society 5.0, this society faces several challenges. It remains a challenge to achieve a comprehensive system in which all nations work together toward a sustainable world [17] that seeks both economic development and solutions to a variety of societal problems of different kinds [16]. In the emerging Society 5.0, a major challenge for society is to ensure security. Since a considerable amount of personal data can be collected and shared across systems in Society 5.0, the implementation of adequate security measures is an absolute must. A super-smart society like Society 5.0 is, is as vulnerable as any other society before, i.e., Society 1.0 – Society 4.0 (Fukuyama, 2018). However, the mechanism by which this vulnerability manifests itself is different, as the characteristics and properties of this society are different from those of previous societies and are therefore unique. The disadvantage and the problem here are that Society 5.0 is not exempt from these usual and already known risks and threats that transpire in conventional society. On the contrary, a smart society is somewhat open and sometimes even more vulnerable to additional types of risk. Some types of threats seem similar to those faced in conventional Society 4.0; however, their unique characteristics and features classify them as the new risks, threats, and thus the challenge to overcome them that come with Society 5.0 [2]. New technologies carry new varieties of potential cyber/digital addictions with them, such as the internet, social media, and online gaming. Studies show that many users of technologies like smartphones, gaming consoles, etc. have an internet/gaming disorder [2], [18]. There are many alternative terms in the literature, e.g., problematic internet use (PIU), pathological computer use (PCU), or internet addiction disorder (IAD) [19], [20]. The Centre for Online Addiction named five specific types of cyber / digital addiction: Cyber-sexual addiction, Cyber-relationship addiction, Net-compulsion, Information overload, Computer (game) addiction [21].

The authors have discussed the challenges in a future super-smart society in previous research [2]. These are divided into the categories of governmental control, cyber technologies, global phenomenon, and social complication. For more insight, the reader is advised to view the previous work [2]. The contribution of this research falls under practical exploratory research with the aim of discovering flaws and building up for interacting methods. Since time is moving forwards only, it is better to be prepare for the future society before too late. The time to explore and intervene is now.

II. Aim and Field of the Forecast

The purpose of the forecast is to have a general understanding of how certain changes in the future will impact society in Switzerland. Switzerland and the Swiss specifics are examined as an example, but the methods and procedures used are designed in such a way that they can be applied to other states or regions at any time. The forecast has the potential to flag flaws in the system and point them out so one has enough time to intervene and address the problems. If the forecasts proves to be useful in this context, then it can also be applied to other areas in Society 5.0 such as energy economy, energy consumption, mobility behavior, and so forth.

The fact that is known is that society is steadily advancing and implementing more technological tools and solutions in every aspect. In other words, the forecast is expected to define a few variables that touch our daily life and predict the changes that will affect them for the next decade. The cause, in this case, will be treated as the independent variable, and the affect aspects will be referred to as dependent variables.

The challenge to find suitable measurable data throughout a relevant series of time is huge. Therefore, the focus in this stage is on the quality of life as it touches every person in the society and because the smart society is supposed to be human-centric as has been discussed before.

The one particular item that is being looked at in this paper in terms of future changes in the Swiss society namely "Quality of Life" is referred to by OECD as well-being. The well-being of humans is determined by both material living conditions and the subjective perception of the quality of life. Among the dimensions of material living conditions are Income and Jobs and Housing Conditions. The immaterial dimensions of the quality of life include Health, Education, Environmental Quality, Personal Security, Civic Engagement, and Work-Life Balance [22]. Fig. 2 is the illustration of the well-being current and future well-being dimensions according to the OECD standards.

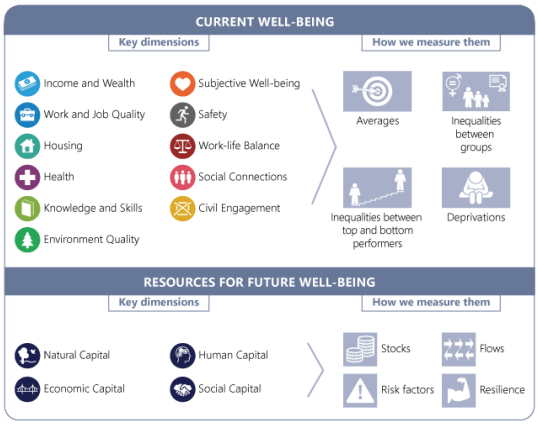

Fig. 2. Measuring Well-being [23].

It is noteworthy to draw the attention to the matter that only very few elements amongst the ones appearing in Figure 2 can be used for this forecast. Issues such as the lack of data and the limited reads when the data is available, in addition to the difficulty if not the impossibility of transforming qualitative data into quantitative ones, are the obstacles that forces the forecast to be run using only the variables that are being presented in this chapter.

In this context, it is possible to define main domains for the dependent variables from the key dimensions of well-being to be used for the forecasts in this paper. These domains are income and wealth, work and job quality, and healthcare.

The derived dependent variables are being selected as per available useful data that covers approximately the range from the year 2000 through 2020. However, to carry out the forecasts, an independent variable had to be defined in addition to the mentioned dependent variables. The ICT investments, which are reported by the Federal Statistical Office of Switzerland annually were chosen. This is because investments in ICT can be regarded as an indicator of technology adaptation, this variable is particularly well suited to act as an independent variable for this forecast. All the variables for the forecast are presented in Table I.

TABLE I: DEPENDENT AND INDEPENDENT VARIABLES FOR THE FORECAST

Independent variable		$X1$	ICT investments
Dependent variables	Income and wealth	$Y1$	Gross National Income (GNI) per capita in USD
	Work and job quality	$Y2$	Unemployment, total (% of the total labor force)
		$Y3$	Labour Force participation in Labour market in full-time equivalents
	Healthcare	$Y4$	Healthcare Costs in million CHF

III. FORECASTING DESIGN AND METHODS

The forecast contains three processes. It starts with Process A which applies to all dependent variables. The correlation between the independent variable and the dependent variables will be measured using the Pearson Correlation Coefficient. If the dependent variable shows high correlation (positive or negative) ≥90% then the variable is qualified to Process B. Otherwise, it is qualified to Process C.

In Process B, the independent variable will be forecasted using the Autoregressive (AR) Model. Then the dependent variables will be forecasted using the Regression Model with their dependency on the independent variable. The outputs will be interpreted and discussed. In Process C, the dependent variable will be treated as a separate variable and will be forecasted independently using the Exponential Smoothing (ETS) algorithm. The design of the forecast is presented in Fig. 3.

Inputs for the forecast can be found in Table II. The source for the data is the Swiss Federal Statistical Office FSO [24].

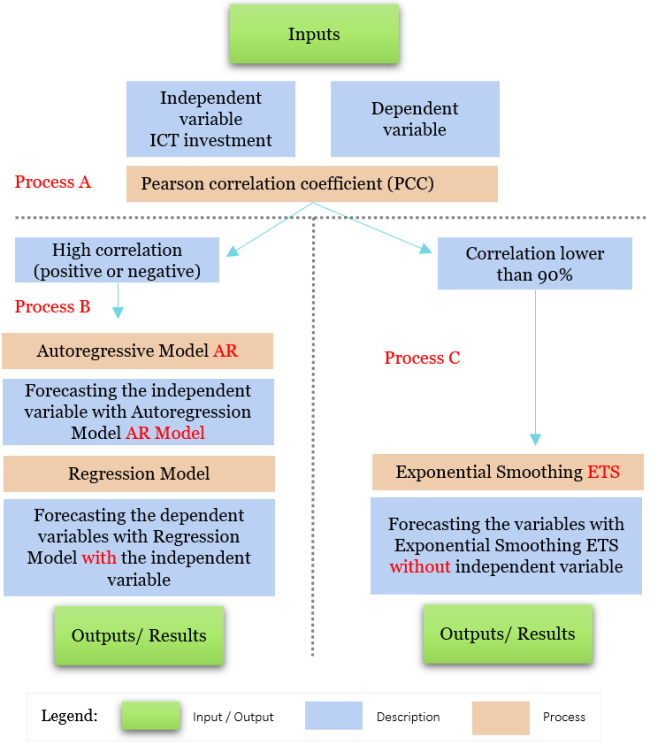

Fig. 3. Forecast design.

TABLE II: INPUT DATA (SOURCE FSO)

Year	$X1$	$Y1$	$Y2$	$Y3$	$Y4$
2000	19,666	43,520	2.67	58.40	43,072
2001	20,489	40,930	2.49	58.40	45,754
2002	21,102	39,700	2.92	58.40	47,629
2003	19,309	45,620	4.12	58.40	49,429
2004	20,466	53,800	4.32	58.40	51,361
2005	21,476	61,620	4.44	58.40	52,388
2006	22,950	63,990	4.00	59.10	53,048
2007	24,779	62,830	3.65	59.10	55,474
2008	25,808	63,190	3.35	59.10	58,563
2009	25,353	70,370	4.12	59.10	61,157
2010	26,517	77,570	4.80	59.00	62,565
2011	26,286	79,720	4.40	59.00	64,243
2012	28,521	84,880	4.49	59.60	66,512
2013	28,653	88,740	4.75	59.60	69,118
2014	28,882	86,560	4.83	59.60	71,429
2015	30,202	85,670	4.80	60.60	74,385
2016	30,682	81,850	4.92	60.60	77,455
2017	32,205	78,920	4.80	60.60	79,643
2018	32,002	83,730	4.71		80,242
2019	33,313	85,500	4.39		
2020			4.94		

The outcomes of Process A are shown in Table III. Only the variable Y2 shows low correlation with the independent variable. This means that variable Y2 qualifies to Process C, while variables Y1, Y3, and Y4 qualify to Process B.

TABLE III: PEARSON CORRELATION COEFFICIENT

Correlation with $X1$	$Y1$	$Y2$	$Y3$	$Y4$
	0.90	0.68	0.93	0.97

Table IV presents the outputs of forecasting the dependent variables in Process B and Process C. Hence that the independent variable "ICT Investments" is forecasted independently using the AR Model.

TABLE IV: FORECAST OUTCOME

Year	$X1$	$Y1$	$Y2$	$Y3$	$Y4$
2018				60.40	
2019				60.63	82,129
2020	33,993	95,886		60.75	83,959
2021	34,594	97,896	4.99	60.86	85,576
2022	35,484	100,870	5.09	61.01	87,969
2023	35,998	102,591	5.19	61.10	89,354
2024	36,762	105,145	5.28	61.24	91,408
2025	37,483	107,556	5.38	61.37	93,347
2026	38,150	109,786	5.47	61.49	95,142
2027	38,876	112,214	5.57	61.61	97,094
2028	39,518	114,361	5.66	61.73	98,822
2029	40,187	116,597	5.76	61.85	100,620
2030	40,859	118,844	5.80	61.96	102,428

IV. IMPLICATION AND DISCUSSION

Fig. 4 illustrates the future development of variable Y1, i. e. Gross National Income (GNI) per capita in USD. The forecast suggests actual growth in the income in the society as a whole. The result shows a strong correlation between implementing technology in the society and the finical prosperity of people. These findings are in accordance with the literature [3], [6].

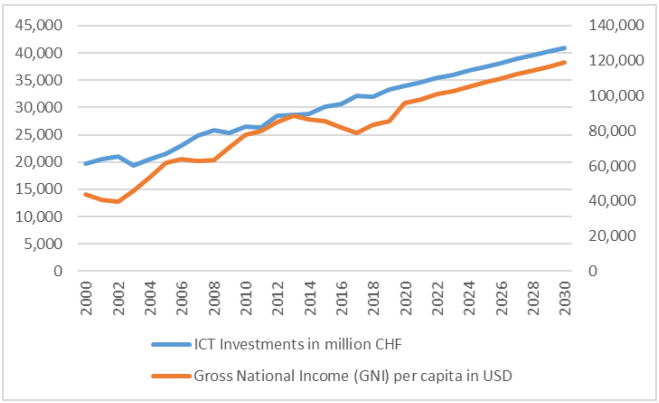

Fig. 4. Forecasting GNI per capita.

The variable "Unemployment (% of total labor force)" Y2 showed no significant correlation with "ICT Investment", and therefore it was forecasted independently. This finding predicts that technology advancements should not carry significant disruption to job market. In some segments, such as retail, there will be job losses [2], [25], but new jobs will be created in other segments thanks to technologies like artificial intelligence [26].

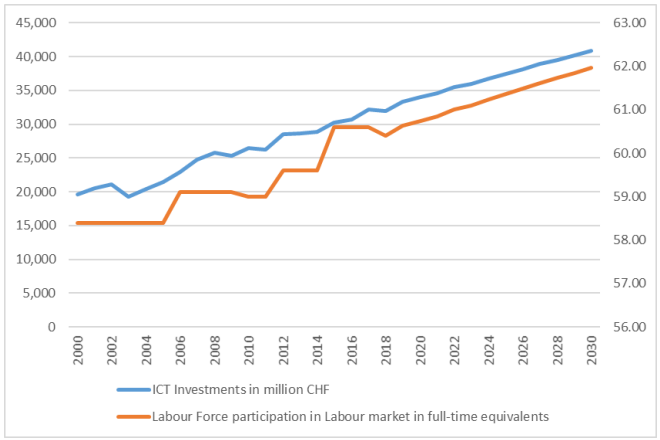

Fig. 5. Forecasting labor force participation in labor market.

Fig. 5 shows the forecast of variable Y3 "Labor force participation in labor market". The forecast is suggesting more occupation for the available workforce in the future. However, this finding contradicts what most literature suggest and contradicts the forecast of Y2 but there might be some explanation.

First, the economy in Switzerland is robust and competitive especially with applying most technologies in every possible industry. Most studies that warn from job shortage are run on global scale, and Switzerland is expected to suffer less. Second, one should keep in mind that this is only a forecast and has its limitations and basically, forecasts are generated based on historic data so one should be careful when interpreting the outcome of a forecast.

For the final variable Y4 "Healthcare costs", the forecast indicates growing healthcare expenses which has historically been the case. The results are presented in Fig. 6.

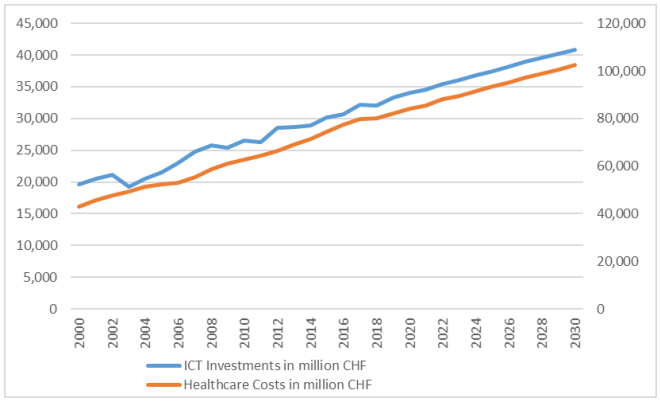

Fig. 6. Forecasting Healthcare costs.

Liking society advancement in terms of technology application directly to increased healthcare costs is not realistic. Even if Y4 shows high correlation with X1, this does not imply necessarily the existence of a causation relationship. Europe is an aging continent, and more people are going into retirement that people going to the job market. This increases the burden on healthcare sector and is not related to technology advances in the society.

V. CONCLUSION

By analyzing the outcomes of the forecasts of the four dependent variables, only one factor will develop in the

future in favor of improving life quality. It is found that the gross national income (GNI) per capita will increase significantly in the future which means hypothetically higher salaries. However, the interpretation of this improvement is on hold until other important elements are investigated. The unemployment rates will not drop in the future according to the forecast. But on the other hand, the engagement of available working force will increase, as this variable is in full-time equivalents. Now, by looking at these three findings together one can come to a conclusion that the salaries will increase significantly for certain segments of jobs and not so much to other job categories. This increase justifies the increase of the GNI per capita. But in the meantime, the gap between classes will increase and lower-class workers will face more difficulties to find a job. All of that with bearing in mind that the healthcare costs will keep increasing.

The quality of life and the well-being of people will probably not improve but it is expected that employment rates of the workforce will rise, and the income of employment will mostly increase. If the quality of life is only dependent on the forecasting variables, then this is bad news for society. There are, fortunately, other factors that could not be treated in the design of this forecast which is one limitation and difficulty as well. Nonetheless, it would be a good enrichment for the research to inspect the remaining uninvestigated elements that are related to the well-being of humans in Figure 2 especially that all these factors together shape a more reliable image on the future well-being.

Now, moving back to the main question: How to ensure that a Society 5.0 emerges that adheres to the principles of digital ethics and security while contributing to sustainable development from which all members of society can benefit?

There is simply no simple answer to that. The forecast tells that there will be flaws in the job market for the future together with tendency of inequality in money distribution. Each of these problems must be addressed now by lawmakers and legislators together with a council of experienced economists before it is too late. Early forecasts and simulations for the future Society 5.0 uncover more weaknesses in the society and now there is time to intervene and tackle these problems one by one.

The implications of the COVID19 pandemic are excluded in this study because they are yet to be observed and measured.

For future research, studying the development of all the factors of the human well-being is certainly worth consideration. It would be also very interesting to further investigate the influence of technologies on different types of society, together qualitatively and quantitatively and to extend the research to cover more comprehensive aspect of life. Another field for future research would be the impact of Covid-19 pandemic on Smart Societies. Another field of experimentation would be to examine the correlation between increasing dependence on electrical energy, the demand for switching to renewable energy and the associated price development, which together again has an influence on quality of life on achieving the goals of Society 5.0.

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