Chapter

Shared Futures: An Exploration of the Collaborative Potential of Intelligent Machines and Human Ingenuity in Cocreating Value

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Abstract

This chapter reports on the exploratory study that aimed at better understanding the conditions under which the combined capabilities of intelligent technologies and human ingenuity could be harnessed to create new efficiencies. The study was conducted within a university setting as universities should model how future societies ought to look like and drive societal change. As the new digital society 5.0 takes shape, the time has come to critically probe one aspect of society 5.0, the leveraging of human-machine collaborations to generate unique ideas and convert them into tangible results. The sequential mixed methods' approach together with a sociocultural lens was used to investigate the ideal university conditions that could foster human-machine collaborations in value cocreation. Nineteen Senior Scandinavian and South African managers were interviewed to elicit their views on how human-machine collaborations could be harnessed to cocreate value within complex university settings. Entrenched cultures, policies, systems, and multiple stakeholder interests which complex into rules and routines mostly define university mores. These university mores are often impervious to rapid newness and radical change. Fifteen advanced undergraduates at one South African university also participated in a quasi-experimentation that investigated team formation and team development within the context of human-machine collaborations.

Keywords: value cocreation, intelligent machines, human ingenuity, human-machine collaboration, sociocultural perspective

1. Introduction

Intelligent technologies represent a major shift in the capabilities of computing machines from performing repetitive tasks within the mainly quiescent algorithmic problem-solving frameworks towards generating smarter solutions through the use of advanced heuristics and active interaction with humans. Algorithmic frameworks are considered quiescent when they rely on a specific set of instructions that totally reproduce expected outputs. The capabilities of intelligent technologies that are most likely to contribute in creative problem-solving, deep learning required in creativity and new discoveries with potential to create value require huge data processing, multiple iteration abilities and huge resource commitment. These three conditionalities of creative machines would enable these machines to generate advanced heuristics that can produce smarter solutions that might still lack formal proofs of their veracity and efficiency in practical situations. The testing of the correctness of the machine-generated solutions and their efficacy in resolving real, practical problems falls within the human realm. This is one area of collaboration between machines and humans. Other areas of collaboration between machines and humans relate to the inability of machines to adapt to real environmental changes, inability to frame and define complex problems as well as inability of machines to negotiate the complex sociocultural realities that can facilitate the adoption of machine-generated solutions in specific organisational contexts. The latter area of human-machine collaborations was the focus of the study that is reported in this chapter. The study sought to understand better the organisational conditions that could enable the adoption of machine-generated solutions and, by extension, those organisational conditions that could be inimical to the use of such solutions. Through the use of a sociocultural lens, the possibilities of human-machine collaborations are first explored through eliciting the perspectives and experiences of senior university managers in areas of innovation and entrepreneurship. Creativity was assumed, in the study, as the plinth of innovation and entrepreneurship; hence, focus was on the realities of key senior players in innovation and entrepreneurship as they actuate in real university spaces. Universities are considered as complex spaces where entrenched cultures that subsume taken-for-granted social mores, systems and policies as well as multiple stakeholder interests determine the activities and strategic directions of the university. Universities across the globe have already adopted technological solutions in varying degrees of sophistication, and some scholars have critiqued the fetishist and ideological manner of their adoption in universities [1]. Some of the major concerns include:

- That university technological response tends to be framed in ways that endow technology with magical power that is capable of resolving protracted problems of academic practices. This framing remains undertheorised and mostly empirically undertested such that it assumes an ideological posture and a marketing-like puffery which attracts scholarly and intellectual critique.

- That technology tends to influence university policies and systems in ways that upset deeply entrenched academic cultures of autonomy and professional identities such that academic autonomy and professional identities get reduced to bureaucratic and technocratic logic [2]. Understood this way, academic autonomy and professional identities are positioned as subordinate to technology without substantial logical and empirical justifications. This subordinated positioning of academic shrines (autonomy and identity) mostly considered as sacrosanct in academia would most likely affect the smooth transition of universities to the cyber-physical spaces of society 5.0. Society 5.0 relies on greater convergence between virtual and real spaces such that a proper understanding of the sociocultural nature of the real spaces is essential in human progression towards society 5.0 which leverages closer collaborations between these cyber-physical spaces. While information society 4.0 relied on the cloud technologies facilitated through the internet to store, retrieve and analyse data, society 5.0 will depend on intelligent technologies to process and interpret big swathes of data elicited through sensors in the physical space which would then be used to suggest and help in cocreation of new value propositions. Knowledge and theorisation around the virtual and real spaces in terms of creating ideal conditions for greater synergy and collaborations between these spaces would be essential in the realisation of society 5.0. The study that is being reported in this chapter makes a modest contribution towards understanding the complexities involved in making society 5.0 possible.

Added to these ideologising concerns around technology is the general marginalisation of creativity, innovation and entrepreneurship in the core academic practices. The entrenched academic cultures tend to sideline human creativity, and the human-machine creativity would find it even harder to negotiate a space within the entrenched strategic core of university curricula. In this sense, there are strong indications that without appreciating the sociocultural aspect of enacting human-machine creativity in universities and even other organisations, human-machine creativity would remain on the margins of such institutions or organisations. It is, in this sense, that the collaborative potential of intelligent machines and human ingenuity as mapping out within a university context was examined through perspectives of key role players in university innovation and entrepreneurship units. This collaborative potential was also examined in terms of the extent to which it impacted team formation and development. The variant of Tuckman's Stages of Team Development [3] as expounded by Crosta and McConnell [4] was used as the basis of analysis. The study is thus a subfield that falls somewhere between the emerging scholarship of artificial intelligence and human psychology within the socio-cognitivist traditions that recognise the value of teamwork in creativity. In the next section, an understanding of the historical trajectory of artificial intelligence and its recent forages into the hallowed spaces of human creativity is developed. Furthermore, understandings of the limits of creative machines which open up possibilities of human-machine collaborations are explored in ways that locate the study in these debates. These debates are then further processed within two main psychological concepts of sociocultural perspective and stages of team development.

2. Framing the study

2.1 Society 5.0

Noted as the supersmart service society and still essentially human-centred, society 5.0 combines innovation, education and social action to generate new value using human-machine capabilities [4–6]. It leverages unprecedented progress in technological advances that allow for human-machine interaction and possible collaboration to cocreate new value propositions that disrupt the current societal and business practices plinth (**Figure 1**).

In a powerful book called *Futureproof*, Minter and Storkey [7] identify 15 forces that will shape society 5.0 and disrupt current societal practices. Three of these forces relate to the mindset and the rest on technological advances. This emphasis on the mindset and technological savvy in shaping society 5.0 illuminates stronger synergistic relations between human psychology and advanced information technologies (IT) that will define society 5.0. Society 5.0 will not be defined by the dominance of intelligent machines over humans but will see greater human-machine collaborations that deliver innovation that result in the creation of a supersmart service society and the galvanising of a quinary economic sector (**Figure 1**). A quinary economic sector is noted mainly for disrupting and reorganising economic activities of the primary, secondary, tertiary and quaternary sectors [2], leveraging big data analytics and relying upon new technologies to create superior human conveniences. There is thus a legitimate need to work on the

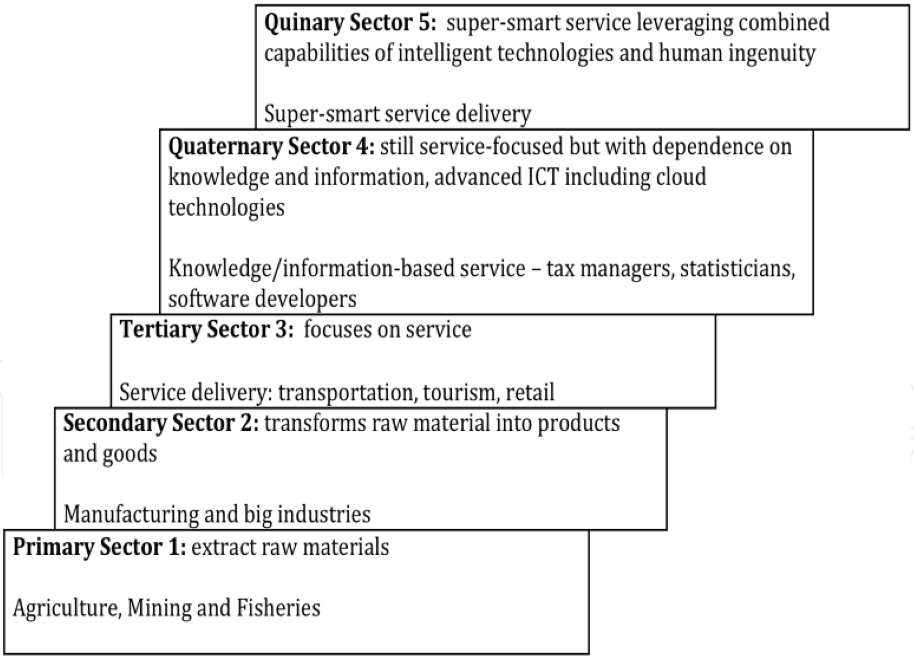

Figure 1.
The evolution of the economic sectors [2].

mindset of people in order to substantially increase their awareness level with regard to the changing nature of the relation between humans and technologies from quiescent to intellectual exchanges. These intellectual exchanges will enhance both the human and machine intelligences. This awareness begins with understanding human-machine interaction within the framework of artificial intelligences and then followed by exploring possibilities of human-machine collaboration that result in innovative ideas. A more growth-focused mindset will be needed if people are to cope and thrive in society 5.0. There is thus a need to develop an understanding of how such a mindset can be cultivated in order to prepare people for the future in which people interact and collaborate with smart machines. A terse historical background is essential so we could put the growth-focused mindset into perspective. Humans are 'puzzles of needs', and every society and its economic activities have been organised around meeting and, in most cases, even creating these needs so as to meet them most conveniently. Humans and tools have been at the heart of figuring out these puzzles of needs and meeting them in the most efficient way. We have termed different stages of solving these 'puzzles of needs' industrial epochs with each epoch building on the previous one and providing a better and more efficient way of dealing with these 'puzzles of needs' through the use of evolving technological advances. The first wave of these technological advances thought to have started in early twentieth century saw the dominance of standardised, routine industrial processes that were organised around assembly line and powered by human muscle as a proxy for real robots. Efficiency was achieved through the measurability of each step of the assembly line and fixed tasks that were sufficiently easy as to be performed by semi-skilled workers. These semi-skilled workers required little formal education and represented, in form and substance, some kind of 'Homo sapiens robots'. The second wave is set to have started in the early 1970s and reached its apotheosis in the 1990s. It is noted for its reliance on advanced information technologies with computers as its key cynosure, large databases and the onset of automation. This economic epoch is also noted for big machines that replaced human muscle as human muscle started increasingly losing its relevance in economic activity, but human cognitive abilities became increasingly sought-after in business and industry as the post-workerist era became a reality. University qualifications increasingly became the basis of securing employment with increased demand for 'fixed' graduate attributes that were purportedly sought-after by industry and business. While the third wave builds on the two waves, it offers an entirely new way of doing things. It leverages AI technologies and human ingenuity in such a way as to galvanise them into accessing real-time data to produce products and services that are highly individualised and optimised to meet human needs in the smartest way possible. It also extricates humans from tedious, standardised and routine work as robots can now assume that role which creates new roles for humans. The third wave thus sees the resurgence of human work albeit in new roles. These new human roles in industry and business will see greater collaboration between humans and smart machines as they collectively search, design, test and scale new or improved products and services, that is, engage actively in cocreation of value. These new work roles and human-machine collaborations will require an entirely new mindset and a new skills set. The 'fixed' mindset of the first and, to a certain extent, second wave will become redundant and obsolete in the next 5–25 years as new work roles emerge at an exponential pace. Dweck [8] argues that a growth-focused mindset thrives on challenges, persists in the face of formidable odds and embraces uncertainty as it innovates and adapts to changes on a continual basis. My strongest sense is that such a growth-focused mindset ought to constantly try out new things, experiment, fail, try again and be able to undertake research projects as it effectively works with highly discrete teams which also consist of non-humans. Society 5.0 will increasingly see the formation of such human-machine teams with AI technologies filtering and doing basic analysis of huge swathes of data and humans converting it into real value with benefits accruing to humans. This will require not only new sets of skills but new ways of thinking and doing things.

A good starting point would be on whether university leadership is ready for this mindset disruption and whether our students can cope with new projects that involve cocreating value with non-humans in the form of intelligent technologies. It was thus particularly important to tease out the readiness of university leadership to embrace the framework of society 5.0 in ways that compel:

- Reimagining university and curricular processes in ways that leverage AI technologies. This would require that universities move away from fixed mindsets that see very little value in creative problem-solving. There is an absolute need for universities to prepare students to collaborate with smart machines to generate new and better ideas that can be converted to tangible results. For the purpose of this chapter, this was a major focus, but there are many areas of university setup that are ready to be disrupted in order for universities to move into society 5.0. Societies rely on universities to prepare them for the next order of things, and it is thus incumbent upon universities to discharge this mandate without fail. Classroom routines can be automated and thus free human teachers from such tedious work and allow them to set up more research projects that involve discrete students-machine teams that engage in creative activities. Known knowledge opens itself up for automation with robots, smartphones and virtual learning providing lessons wherever students are with less concerns to attend classes in physical spaces. Human teachers could become industry, government and community consultants as they prepare society for society 5.0 which could become a serious cultural shock and pose new risks such as cybersecurity and ethics of human/robot behaviours that could be detrimental to humans.

- Establishing groundwork for human-machine collaborations that could help usher in the super smart service society.

- Rethinking the business of human-business relations in ways that ethically optimise redistribution of wealth, eliminate inequality and harmonise race relations.

Through interviews with university leadership in innovation hubs and entrepreneurship centres, I sought to better understand how universities in two different contexts reacted and prepared themselves for these mindset and operations disruptions. My sense was that how universities treated leadership in these university entities (hubs, centres) and how this leadership in university hubs and centres challenged entrenched university cultures would provide a preliminary framework of how university readied themselves for society 5.0 or, if you like, the age of AI. I also conducted the quasi-experimentation on how students related to smart machines that actively interact with them as equals. I used a simple AI technology version called Google Assistant mainly because it appeared to be a simple but more advanced interactive AI technology in comparison with a similar Apple assistant device called Siri. I opted for the simplest human-machine interaction because the purpose was more to determine the potential of human-machine collaboration especially the complexities of team development. This study was thus a baseline research on human-machine collaboration. It offers insights on how these possibilities of fusing human ingenuity with intelligent technologies could map out within a university setting. The study also sought to avoid presenting this chapter as a polemic for AI rather sought to provide a framework that could lead to theorisation around supercreativity as it pens out in a university setting. The realities of society 5.0 are already with us. The largest economy in the world, which is that of the USA, is already feeling the impact of society 5.0. Over the period between 1990 and 2007, the US manufacturing sector lost 670,000 jobs as a result of automation [9], and the picture looks bleak on a global scale as more than 6 million jobs have been lost to industrial robots and automation technologies, and as we approach society 5.0 realities, the picture of human-based jobs looks bleaker in the manufacturing and agricultural sectors. It is estimated that 73 million jobs are at risk of being automated in the next 5–10 years [10]. In the US agricultural sector and between 1990 and now, 41% of Americans were farmers, and today that number is around 2% [9] as smart agriculture takes effect and the traditional one declines more in society 5.0. It is important to note that automation, one of the defining features of society 5.0 that will grow exponentially, includes capital, software, smart machinery, robots and artificial intelligences (AI), and its impact is often invisible and requires astute leadership. It is, however, a misnomer and a false narrative to assume that automation and digitisation technologies only lead to job losses. New technologies disrupt traditional work patterns but create new opportunities for new kinds of work and new roles for humans in the workplace. For instance, in the UK, research on impact of new technologies on the work market shows that by 2037, new technologies will create more work than it sheds. It is estimated that the healthcare sector will create more than 1 million jobs and other sectors with growth prospects include law, accounting, advertising, cybersecurity, robot technicians and education if it invests now on developing fusion skills (human-machine capabilities) via multiple platforms and accessing requisite expertise across the globe through optimal use of new technologies. These issues form a backdrop of the study that was undertaken within the university setting on teasing out the human-machine collaborations for cocreating new value propositions and possibly compelling a rethink of how universities should prepare and ready themselves for the inevitabilities and disruptions of society 5.0 (**Figure 2**).

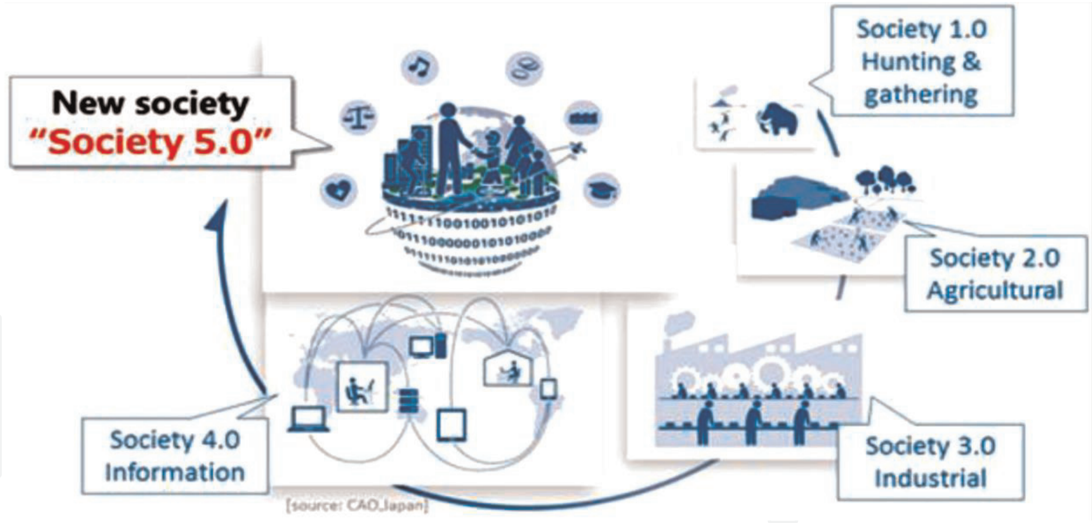

Figure 2.
Societal evolutions (adopted from: 2017 Conference Proceedings on Future Services and Societal Systems in Society 5.0).

2.2 The creative potential of intelligent technologies

The ubiquity and power of computational capabilities increased substantially in information society 4.0 and are set to exponentially grow in the digital society 5.0 albeit in ways never imagined before. Big data analysis and interpretation by intelligent technologies, internet of things, robotics and other new technologies will, in the society 5.0, exceed human capabilities and generate new value propositions in areas of mobility, agriculture, health, energy and all aspects of human needs. For instance, diverse data from automobiles, weather forecasts, traffic, accommodations, tourist attractions and personal preferences would be recombined and reconfigured by intelligent technologies in ways that benefit the tourism industry. Mobility of the elderly and physically impaired will be substantially improved with advanced and smart wheelchairs. We will, in society 5.0, talk about smart manufacturing that employs intelligent technologies for interplant coordination that produce greater efficiencies that were never imagined before and smart healthcare that use intelligent devices in storing, retrieving and interpreting physical and medical data as well as use drones to provide on-time delivery of medications. New value creations will even reach the agriculture sector resulting in automated tractors, automated water management and self-driving delivery cars.

These new value creation opportunities would not have been possible without shifts and advances in technological capabilities. In the past, smart machines required that they be programmed and reprogrammed in order to perform specific tasks. This is what I call operating within quiescent algorithmic frameworks which, in the past, reduced machines to complimentary but generally passive tools. More than two decades ago, advances in technologies offered new possibilities in the interface between humans and machines. Technologies, especially computer technologies, had so advanced as to allow them to contribute in aiding cognitive processing, anchor intellectual performance and enrich human intellect. The shift was on effects and capabilities that technologies had on humans and moved from effects of technology to effects with and of a technology. Salomon et al. [11] define this distinction thus 'effects with technology occur when people work in partnership with machines, whereas effects of technology occur when such a partnership with machines have subsequent cognitive spin-off effects for humans working away from machines'. These crucial and early scholarly rumblings on the relationship between machines and humans focused largely on the implications of such technological advances on human cognition with some scholars arguing that this new partnership between humans and smart technologies would lead to reexamination of prevailing conceptions of intelligence and ability [11–13]. The questions revolved around intellectual property ownership in terms of whether the intellectual benefits that accrue from the human-smart technologies collaborations should be attributed to humans or whether they must be acknowledged as joint ownership with the status of smart technologies ownership posing a complex conundrum. This conundrum was, however, not new especially in education and human skilling as Pea [14] and Papert [15] raised the issue almost three decades ago in relation to ordinary and scientific calculators' role in human thinking and learning processes especially the resultant cognitive residue attribution. There was going to be an inevitable attribution effect and opened a research gap on the relationship between humans and intelligent technologies. With the advent of expanded intelligent technologies which now includes AI capabilities, the conundrum would be even more pronounced given the huge resource commitment that comes with the use of AI capabilities. This conundrum would extend to the human-machine collaborations for cocreation of value with the questions arising as to who becomes the owner of the innovative idea or new products. This matter is relevant to this chapter because human-machine partnerships for value cocreation include issues of not only intellectual property rights but also the commercialization of the generated creative ideas. For instance, within the university and developing countries context, these AI capabilities will most likely be accessed via universities by the share weight of their costs and opportunities to use these human-machine collaborations, for value cocreation could only happen in these spaces. The question of the ownership of the generated creative idea and its commercialization would naturally develop into a conflict and clashes with established cultures in universities and developing countries. In developed countries such as in Scandinavia, such ownership of new ideas and accruing commercialization benefits go to the generator of the innovation as clearly articulated in their national innovation strategies [6, 16, 17]. Even when that is the case, data collected in selected Scandinavian universities show that the university cultures have ensured general marginalisation of such practices. Universities generally play a minimal role in such activities because very little incentives accrue to the university as all costs of the innovation centres, while located within universities, are met by the government including staff salaries, office space and the whole administrative shebang.

Partnerships between humans and machines would become even more acute when humans realise that automation poses a threat to their well-being and unless clear protocols of use in the production system and innovation are clarified. Scholarly work has been done on the trust levels between humans and machines which demonstrates that lack of clarity on the roles of intelligent technologies in productivity and performance could be counterproductive. It is not difficult to discern that the following five benefits will accrue to companies and industries that leverage intelligent technologies capabilities that include AI. These benefits are increased flexibility of the work, speed of task completion, scale of productivity, and quick and superior decision-making processes based on big data interpretations that smart machines make possible. The companies, according to Xu and Dudek [18], that harness the collaborative and combined intelligence capabilities of both humans and smart machines are likely to be highly effective and competitive. According to Xu and Dudek [18], smart machines expand human abilities in three ways through amplifying humans' cognitive strengths, automating routine tasks and freeing humans to focus on innovation and other tasks the smart machines cannot perform. However, they argue that in order to optimise human-machine collaborations and increase trust between humans and machines, humans ought to perform three tasks such as training machines to perform certain tasks, explain the outcomes of those tasks and ensure the sustainability of machines in ways that ensure that machines do not harm humans in anyway. Other studies on trust issues between humans and machines focus on experimentations and simulations to measure how trust impact overall tasks completions and performance in organisations that employ human-machine collaborations [5, 19, 20]. Other studies on collaborations have signified the role of trust in team formation and development. These studies are equally important in human-machine collaborations as they go into the heart of organizational culture and how it could be affected by human-machine collaborations. The way human-machine collaborations could affect organizational culture and illuminate factors such as trust or mistrust of technological advances was measured in this study through the use of qualitative and quantitative measures. Similar to Xu and Dudek [18] observation and my own study that is reported in this chapter, trust studies on human-machine collaborations highlight the reality that organisational culture could torpedo the good intentions of human-machine partnerships. While studies that investigate trust relations between human-machine interactions focus on achievement of optimal performance by paying attention to delivering suitable and practical measures of trust variables that can be harnessed for high performance, a modicum of attention is put on the role of organisational culture in ensuring the successful use of human-machine collaborations. Freedy et al. [5] study on trust variables regarding human-machine collaborations developed and experimentally tested trust variables within the mixed initiative team performance assessment system (MITPAS) using simulations. The testing was based on the degree to which the levels of robot autonomy as well as its adaptive automation enhance soldiers' teleoperation and limit the continued use of such human-based task within the framework of trust. In other words, how far should technology go in terms of automating this human function without alienating humans which could potentially affect task accomplishment and the success of the mission. The results show that while teleoperations could be fully automated, critical performance factors of human teams such as information exchange gleaned from intelligence, coordinated communication, expected soldier behaviours in such missions and team leadership remain central to the successful mission accomplishment. Although automation via robots took away aspects of human tasks in a mission, it accentuated other aspects of human abilities as harnessed through teams such as the degree of predictability of each stage of the mission, leadership and risk assessment. This way, the findings show, the human-machine collaboration became effective.

When applied within the creative design where value creation becomes key, Pu and Lalanne [21] identify complex cognitive processes, artistic intuition and a rich repertory of knowledge and experiences as exclusive domains of humans that make exploration of new possibilities probable through targeting current imperfections in the world. Humans will therefore, according to the authors, play the role of framing the exploration, while intelligent technologies will provide big data analysis and processing. Their study focused on developing an architectural method of harnessing human-machine partnering for designs that target newness or higher designs of existing things. The results show that semi-automation and human collaboration are likely to harness the capabilities of human = machine collaborations. These conceptions of human-machine collaborations occurred at the time when intelligent technologies were still moving into the deep learning mode. Currently, these machines are capable of deep learning and thus can adapt to different tasks with little or no human effort. It is this ability of smart machines to adapt and learn deeply that has opened possibilities for these technologies to attempt generating creative ideas, concepts or models. As a result of the confluence of three main factors, the AI capabilities have been profoundly enhanced to a point of considering them for providing creative solutions. The first factor involves swathes of big data that get filtered and analysed in ways that can lead to reorganisation, recombination and reinterpretation of data, concepts and ideas such that unique, unexpected ideas or patterns could emerge heuristically. However, the current deep learning models of smart machines rely on massive datasets that must still be labelled by humans so that the system could understand what each piece of data represents. This is what is called supervised learning that depends on humans for data labelling which is quite tedious and laborious. The data labelling can also open itself to human bias and thus compromise the quality of such learning. If deep learning models are going to be more efficient in creating value and generating useful ideas, then these models are going to require scaling-up across complex and highly diversified tasks and shift towards small datasets. For smart machines to generate real value then attempts will be required to:

- Find ways of training systems to function on small datasets.

- Develop means for these systems to achieve symbolic reasoning

- Develop capabilities that allow these systems to learn in an unsupervised manner, that is, be able to use raw, unlabelled data to generate real value with little or no human effort. There are currently important pointers towards teaching systems to reason albeit in narrow applications such as in self-driving cars. There is still a lot of work yet to be done to achieve system's deep reasoning.

The second variable in the AI growth equation entails the graphic processing units (GPUs) which allows for complex computations.

The third of such factors relates to the re-emergence of old AI computation model that makes deep learning possible. However, as indicated earlier, more effort will be required to push towards unsupervised learning, and AI computation is insufficient as new algorithms and possibly even more advanced hardware will be necessary to grow AI into deep reasoning spaces.

With considerable effort, the combined capabilities of data, GPUs and deep learning could facilitate greater AI growth and efficiency in creating value and constant generation of useful ideas that can be translated into tangible results. Current machine capabilities require human effort to function optimally and are also still limited in terms of executing common-sense activities and improvising in order to adapt to real-life complexities. This state of affairs allow for human-machine collaborations in generation of useful ideas and translating them into real value. In summing up this sub-section, it is important to point out that there is a tendency to limit the meaning of creativity to disrupting established patterns through reorganising, recombining and reinterpreting data, ideas and concept. While these issues form part of creativity, creativity is more than just the generation of unique or unexpected ideas. When those ideas, despite their statistical rarity, do not lead to usefulness or human conveniences (social impact) then such ideas lack proper salience and cannot lead to real value.

2.3 The collaborative potential of human-machine partnership in value cocreation

Until such time that machine learning could be unsupervised such that these systems could use raw, unlabelled small data to generate reasoning capabilities that allow machines to function optimally across broader swath of applications and in real, complex situations using even common-sense capabilities, then human-machine collaborations will become the order of the day in value cocreation over the next two to three decades. In this sub-section, I attempt to look at possible areas of these human-machine collaborations. I have already pointed to those areas of collaboration and only seek to make them more logical and clearer. Areas for possible human-machine collaborations include:

- Use of machines to source, analyse and interpret large volumes of data which humans use to resolve real, protracted problems.

- Humans adapt unique ideas or concepts generated by smart machines to real situations to create real value.

- Machines identify previously invisible inefficiencies through sensors in complex industrial and logical systems, and humans develop means of eliminating these inefficiencies.

- Digital simulations allow for the design and testing of virtual prototypes which humans can refine and adapt in order to create real value.

The capabilities of smart machines to analyse, interpret, reorganise, recombine and reinterpret data allow humans to improve existing products and services so as to increase their salience and efficiency and thus both cocreate real value. These human-machine collaborative capabilities also provide for the development of products and services that are disruptive of existing order of things.

3. Human-machine supercreativity in complex university settings

Universities have traditionally been designed to conduct research and teach. Overtime, universities have become implicated in the resolution of protracted societal problems but have also been experiencing high-level and high-stakes evaluations in the form of university rankings and strategic planning which were attempting to alter the very plinth of what a university is meant to be so they could function as quasi-businesses. In the South African context, universities have been given an added burden of resolving historical inequality and poverty. These profound and sustained strategic onslaughts on the university have, however, failed to fundamentally change the culture of university as academic autonomy and professional identities remain deeply ingrained. This issue demonstrates that change strategy alone is not enough to change cultures and mindset. There is a need for something more than a change strategy to affect mindset shift and significantly change a culture. As Peter Trucker once stated 'culture eats strategy for lunch'. At the heart of this quote is the need to develop a deeper understanding of organisational culture and a sociocultural analysis which becomes crucial in trying to understand how change can be effected in any organisation. Given that creativity has had a difficult relationship with faculty, curriculum and pedagogy [1] and technology use within universities has been criticised for its undertheorisation and fetishistic implementation [1], supercreativity, as others prefer to call the human-machine collaboration to cocreate new or improved value, would find a generally hostile university environment. Adapting the model developed by Daugherty and Wilson called MELDS, and incorporating aspects of a sociocultural perspective, I attempt to better understand the conditions under which supercreativity could survive and thrive within a university setting.

Mindset (*Meds*): Universities are large complex systems that have developed certain entrenched social processes that translate into deep-seated cultures. These social processes and university cultures privilege certain mindsets and displace the others. Most universities subscribe to the notion of *Magna Charta Universitatum* that European universities have formalised in a document. The charter recognises and makes sacrosanct academic freedom and formation of professional identities. These identities form over time and are often driven by a strong scholarship and values. Some of the key academic values that shape cultures of universities subsume openness to ideas and multiple if not opposing perspectives, deep awareness of own beliefs and their limitations, a non-judgemental attitude that makes academics to be slow to judge and wait for evidence and outcomes of critical analysis, a cognitive flexibility that remains open to new possibilities as well as adaptability to newness. This academic mindset allows universities to be open systems that are presumably malleable to newness, but as Becher and Trowler states in *Academic Tribes and Territories* [22], professional identities can lead to narrowness, group myopia and defence in ways that could make universities inimical to external change initiatives. It is particularly important to appeal to the malleable aspect of the academic mindset and that requires working within the framework academics better understand which is that of research and rigorous theorisation. Part of what posed resistance to technology by academics was its enactment in technocratic ways that insidiously encroached on their academic practices and professional identities [21]. As a way of negotiating an academic space for supercreativity, there is a need to work on the mindset of academics through their own research and theorisation framework. In the next sub-section, I provide and elaborate on this framework as a way of providing a model for changing academic mindsets.

Experimentation (*mELds*): If universities are to adapt to the realities of society 5.0, then they need to reimagine and rework its entire university plinth (strategy, PQM, curriculum, research, pedagogy, community engagement) around artificial intelligence (AI) technologies, automate repetitive lecture sessions based on known knowledge and experiments and access expertise throughout the globe in real time using advanced technologies. This adaptation to the disruptions of traditional university plinth would require reimagining the entire university business. The new university plinth could involve virtual lecturing (lecture sessions), on-time access to expertise across the globe, new modules around human-machine collaborations, and super-creativity delivered on an international platform. This international platform could use multiple accreditation mechanisms that enhance students brand (nothing wrong with a certificate that bears emblems of more than one knowledge institution preferably university-university, university-industry or university-specialised colleges accreditations). Joint student-staff research projects on supercreativity, innovation that leverages digital simulations and supercreativity-driven entrepreneurship using multiple platforms and accessing expertise globally will become normal in society 5.0. These are hugely experimentation precincts and they require urgent adoption. However, their adoption needs to be done in ways that do not alienate academics through undermining their academic autonomy; rather a deep commitment to incentive schemes that encourage change processes in research, teaching and curriculum would most likely nudge academics to realities of society 5.0. When Research Directorates incentive grants favour joint research undertaken with students on supercreativity, innovation based on digital simulations and supercreativity-based entrepreneurship, then chances of success increase and traditional identities based on group loyalties could exponentially vitiate. When teaching grants favour the use of virtual learning, access to expertise on a global scale and in all sectors of society through the use of technologies as well as joint research projects with students, commerce, industry, retail and local communities, then positive adoption could occur.

Leadership (*meLds*): University leadership has a responsibility to prepare universities for the next wave of new technologies that will alter the business of universities in very extraordinary ways in the next 5–25 years. There is an urgent need to revisit all university policies and align them to the realities of society 5.0 so universities could help communities of commerce, industry, retail, politics and ordinary local communities to adapt to society 5.0 realities or risk irrelevance which is worse than death. University leadership needs to change the entire university business plinth as expounded earlier and rally it around the joint capabilities of new intelligent technologies and human ingenuity. The time to craft a new university strategy around AI and other new technologies as well as around human ingenuity is now. Universities that remain stuck to traditional modes and business plinth may need to learn lessons of the manufacturing sector and realise that education and work will need to be reimagined in the age of society 5.0. The study that is reported in this chapter makes an extremely modest contribution to that debate. In fact, it is only scratching the surface but provides a starting point to initiate a new narrative within a university setting, one that takes the sociocultural realities of a university into account in matters of crafting smart strategies for the university. Smart strategies will have to shift focus away from traditional task-oriented operations towards investing heavily in human-machine collaborations and activities of supercreativity.

Data (*melDs*): Universities have always been driven by big data and have historically struggled to manage it. With new technologies such as Hadoop, storing big data has become quite a cinch. The critical issue and of relevance to this chapter is what to do with these big nuggets of textual and numerical data sourced in multiple ways and through all types of formats including sensors, RFID tags and smart monitoring most of which are either structured or unstructured. There is a need to develop some form of organising these big data. This can be organised in terms of the time or period when such big data is available which is termed 'periodic peaks'. The organising of such data could also be done in terms of relevance to a particular aspect of university business (strategy, PQM, curriculum, pedagogy, registration and censors, security including cybersecurity) and more importantly on how it helps universities to drive supercreativity, smart innovation and technopreneurship. A smart scoping review of these big data could make these data relevant to creativity, innovation and entrepreneurship through cleansing, connecting and correlating such data with cocreation of new or improved value. A smart scoping review combines the human-machine capabilities for accessing stored data, cleansing, connecting and correlating these data with value creation.

Skills (*meldS*): Society 5.0 renders traditional skills inadequate but creates new opportunities for fusion skills. While the concept of fusion skills is relatively new especially when used within the university context and requires better understanding so it could be integrated into courses, graduate attributes and form part of core curricula. Fusion skills serve as a collective concept for the effects of digital disruption, that is, these kinds of skills have the capability to fundamentally alter workflows, business models and relationships of value creation such as, in the university context, strategy, PQM, curriculum, pedagogy as well as research and scholarship. For the purpose of this chapter, fusion skills are understood as creative skillsets that support:

- Smart team formation and leveraging of human-machine capabilities to create new or improved value propositions

- Development of smart innovation and technopreneurship

- Broad and smart collaborations that disrupt traditional modes of partnerships in the classroom that is based on in-house expertise towards smart collaborations with experts all over the globe and machine-based expertise (Siri, Bixby, Google Assistant and videoconferencing to state the easy-to-access intelligent technologies)

4. The research design

4.1 Context and purpose of study

This study was undertaken within two different geographical contexts—Scandinavia and South Africa—in order to make a comparative case of how creativity and innovation are handled in these spaces. As earlier stated, universities feel the urge to protect academic autonomy and professional identities, and if these two factors are ignored, then mindset shifts towards society 5.0 could be significantly delayed. In Scandinavia, attempts are made to drive creativity and innovation from the national government level through setting their agenda and strong financing, yet these activities remain on the margins of the core university activities because the National Innovation Strategy did not take into account the sociocultural aspects of the universities. Given that society 5.0 somehow demands that universities ought to embrace and leverage more fervently and passionately the benefits of combined capabilities of intelligent technologies as made possible by artificial intelligence (AI) advances and human ingenuity, then a more measured approach, that is, one that accounts for the entrenched institutional culture is most likely to help universities to ease into society 5.0. South African universities have an added burden of resolving social ills of poverty, unemployment and inequality, yet they have mostly and obdurately sought to emulate strategies, PQMs, curricula, pedagogy and research of developed countries as they chase the mirage of top rankings. The very notion that universities are ranked on the basis of research outputs with inadequate additional indicators on impact of such research on society and its future prospects is problematic. These extra indicators in league tables could help nudge universities into society 5.0. In both contexts, there is a strong call for universities to drive creativity and innovation, yet these activities remain largely outside the core university plinth. Annual reports of these universities paint a clearer picture of this general marginalisation. The purpose of the study was thus to understand better the conditions under which those that drive innovation and entrepreneurship in universities operate and how supercreativity could possibly negotiate a space in these complex university spaces and help drag universities into society 5.0.

4.2 Sampling and selection

Universities: Five Scandinavian universities were selected via an exponential non-discriminatory snowballing technique. I linked up with my network in one of the Swedish universities who arranged that I become a guest researcher in their Centre for Engineering Education for 3 months. He also arranged the first interview with the Deputy-Dean for Innovation and Collaborations who then pointed me to the Directors in Innovation Hubs and Centres for Entrepreneurship. These Directors, in turn, suggested names of Directors of other universities. I was able to interview 13 of these Directors from five different Scandinavian universities.

The three South African universities were selected on the basis that they were considered as the top three innovative universities in South Africa. This ranking was done by and is available in the 2017 Clarivate Analytics Report. All these three universities are research-intensive. The Directors of Innovation Hubs, Technology Transfer units or similar units dealing with innovation within these universities were interviewed. All in all, 6 Directors were interviewed totalling 18 research participants.

Digital artificial intelligence (AI) assistant tools: Given that the main purpose of the experiment was to better understand the conditions under which humans and machines could interact and possibly collaborate in the creation of new value propositions, I sought a more advanced but simple digital AI assistant tool that is easily available and easy to use. The digital AI tool could be available on any computer or mobile devices. Three such latest and smartest AI tools that facilitate human-machine interactions are Google Assistant, Apple Siri and Samsung Bixby. The Google Assistant has proved to be the most advanced tool in this area of technology. It is capable of:

- Showing photos and diagrams that are taken within few weeks and within specific locations. This capability can facilitate human-machine collaboration in generation of ideas especially when baseline graphic information is required to trigger idea generation.

- Providing instance (and contextual) answers from the web and is capable of responding more specifically to most questions posed to it. This ability comes handy in terms of saving time for humans in searching for answers in huge swathes of information. It is a technological ability that could assist humans in identifying different categories of information and ideas and help with sound judgement. It also helps humans on scoping reviews of existing ideas, concepts, products and services given that creativity is about finding ideas and concepts with statistical rarity.

- Developing a memory of information and knowledge that you have previously searched. It makes it possible to ask follow-up questions and receive sensible responses.

- Reading poetry, telling a joke and translating foreign phrases. The activity of generating new or improved ideas requires multiple perspectives and combinations, recombinations and reorganisation as well as reinterpretation of information, ideas, concepts, art and so on and in whatever language as such this technological capability brings these possibilities to the fore.

- Handling complete conversations with its users, and its protocols and heuristics are open to third party developers which allows for own application which can be deployed to the Google Assistant across the globe and thus making collaboration on such a scale possible. It can thus be used to create diverse teams that can collaborate on the same Google Assistant mock-ups.

- Collecting feedback and comments on collaborated creative designs. Its Botsociety API allows changes in the design and multiple iterations such that a design could be refined and be ready for prototyping via digital simulations.

Based on these benefits, Google Assistant was preferred and selected over Siri and Bixby in the experiment.

4.3 Research methods

4.3.1 Interviews

Eighteen Directors of innovation hubs and entrepreneurship centres from Scandinavian universities and three from South African universities were interviewed on:

- Situatedness of their entities within the university, that is, whether they formed part of the strategic core of the university or remained on the margins
- Whether critical and creative thought was explicitly taught within the core university curriculum or in their entities
- The state of readiness for their entities and universities to embrace artificial intelligence (AI) capabilities and contribute in shaping society 5.0 and its 15 forces of disruption [5] and factors inimical to university or entity readiness

Students that participated in the experiment were also interviewed with focus on:

1. Their expectation on interacting with Google Assistant and whether they have interacted with any of these AI technologies before such as Siri, Bixby or any advanced intelligent technologies
2. How they were coping with interacting with Google Assistant (ease of use, confidence, helpfulness in finding answers, reliability of answers, what can be done to optimise the interaction) during and after the experiment

4.3.2 Quasi-experimentation

Four teams of mostly advanced undergraduate students were involved in this project pulled from a database of students who have already submitted their innovation projects to the university for possible assistance. Projects included the use of waste to produce electricity and web application development for selling second-hand books, an application for Smart Logistics. Teams had a simple task of using Google Assistant to scope the statistical rarity of their project idea, that is, whether no or very few people or businesses have already set up such a product or service. There had to be clear evidence of such statistical rarity. They also had to be clear about the need they are creating and attempting to meet and use Google Assistant to filter and analyse multiple nuggets of information pulled from Google Assistant. Google Assistant is capable of building a memory and history of number of times visited on a similar topic, periodic peaks as well as trajectory and nature of visits. Teams also had to demonstrate how Google Assistant helped them shape their approach in creating and meeting a need including competitors (statistical rarity of idea/approach) and possible benefits that will accrue to the customers/ target market. Observation of teams was done with two research assistants and we compared notes. These research assistants are postgraduate students in IT and programming. They helped retrieve evidence on the interaction of students with Google Assistant.

5. Findings and explanations

The Scandinavian Directors indicated that governments mainly drove innovation and entrepreneurship within universities through generous funding that includes fully furnished offices, salaries and small seed-funds. They also confirmed that critical and creative thinking were not explicitly taught within the core university curriculum and even within their units. Centres for Entrepreneurship offered both contact and online formal entrepreneurship programmes up to doctoral degree but their undergraduate entrepreneurship programmes have tended to struggle for space in faculties:

'some of our entrepreneurship programmes tend to be removed in preference of more traditional courses...but we keep trying to secure room for our programmes'.

There is a general acceptance of the digital tools mainly as quiescent platforms for online offerings, desktop research and as part of university operations:

'we have really not started to appreciate the huge potential of AI in entrepreneurship as an ally and to come to your question, we have not even started to explore the human-machine collaboration in driving creativity and innovation'.

The Directors also share the view that if creativity is generally marginalised on the core undergraduate curriculum, then human-machine creativity may struggle even more to find space. These Directors also indicated that Swedish universities are co-signatories of the *Magna Charta Universitatum* that defends academic freedom, and thus external change efforts may struggle to gain traction under these entrenched university cultures. Innovation Hubs tend to mostly use the NABC model to determine the ideas pitch and provide little training in terms of generation of novel ideas. In South Africa, the positioning of innovation units similar to Scandinavia remains generally outside the core university units and serves as support structures rather than as core academic activity. Entrepreneurship is mostly located in Business Schools of these three South African universities.

The results of the experiment that was undertaken with students, while preliminary and quite precarious, suggest the following team formation framework as also extrapolated from Costa and McConnell study [4]:

Emerging contours of smart team formation:

1. Pre-connectivity

There is a strong view coming from the research participants via interviews that they needed to be properly prepared for the activity in terms of:

- Developing a common understanding as human teams prior to engaging with Google Assistant. The main challenge here was that teams were formed in terms of their diversity, that is, in relation to the courses they were doing rather than on the projects they were currently running. For example, a team would consist of advanced engineering undergraduate student, a computer science student, an HR student and a humanities student. Only two teams were kept homogeneous and with their current project. The students believe developing a common ground on what to explore as a new or improved idea while trying to harness diverse knowledge bases require more time. There are just too many variables to manage, and this is seen as counterproductive from the perspectives of the research participants, 'we spent more time arguing over what our project should involves (sic) and how we could use Google Assistant to help us'. While this is seen as a constraint, it is equally an important aspect of becoming creative, and while it was a major source of frustration, it demonstrated the difficulty research participants have in shifting their mindsets that was the primary purpose of the experiment. The homogeneous teams seemed to have already overcome some of these initial team challenges.

- Most heterogeneous teams failed to go through the first stage of the experiment, that is, agreeing on the project. Two of the teams were from engineering, and we kept it as intact because they were already working on some innovation projects that focused on turning organic waste into energy. The projects of these two teams had already advanced to how the waste bins in restaurants and hotels could be developed to become the first stage of transforming waste, that is, mixing this waste and how urine could be harnessed to generate energy. Access to Google Assistant helped them gain knowledge such as waste mixing for energy yield which takes almost 30 days to be ready for the next stage of transformation, and Google Assistant also pointed the team to some relevant videos.

2. Connecting/connectivity

There are obvious challenges when teams attempt to link up with intelligent technologies such as Google Assistant. These challenges appear to develop into a typology of apprehension, doubt and cynicism when teams have not resolved what their project is about and how the intelligent technologies could help the team to shape the project. Teams that have a clear project tend to embrace the interaction with intelligent technologies better than those with a vague project and demonstrate less apprehension, less doubt about the efficiency of the team-Google Assistant interactions. Given that teams actually connected with Google Assistant in computer centres that all students used meant that each team member would have to use earphones so they could not disturb other students. There was no attempt, at this stage, to develop virtual teams that could enable cross interaction between human teams and human-machines teams within the digital space which meant that human-machine interaction occurred at an individual level. Team members then met to share information generated via interactions with Google Assistant. This led to some early superficial learning, more like sharing notes. Team members still had to agree on which information to pursue further with Google Assistant. Given the limited time I had for this experiment and indeed the experimentation is ongoing, the next stages of team development are really hypothetical and will still undergo rigorous experimentation including the identified preliminary stages of team development. My informed conjecture is that beyond the *connectivity* stage, *early superficial learning* will follow.

3. Early superficial learning

Once teams recognise the value of intelligent technologies such as Google Assistant in their projects, an exploration of what such smart machines can offer tended to follow. At this stage, learning is more focused on testing the potential and limits of the smart machine. This learning is superficial because it does not contribute directly to resolving issues in the project. Few of our research participants have not been actively using any of these intelligent technologies which might explain this exploration. There is a need to determine whether this stage may not be redundant under conditions where students have a regular use of Siri, Bixby and Google Assistant. The additional condition could be to determine the level of proficiency in using these technologies. Those research participants that have gone beyond level 1 of these technologies would most likely have a better use of these technologies than those who are using them for the first time. More experimentation will provide evidence of whether this stage is necessary or can be eliminated.

4. Intense interactivity

Following from the previous stage, the degree of interaction with Google Assistant increased substantially once its potential benefits in helping teams to work on their projects increased. As stated earlier, research participants who have beyond level 1 proficiency in working with these technologies would most likely show intense interaction with these technologies to a point where learning goes beyond understanding how the technology works to being able to interact and possibly even collaborate with it as efforts of cocreation of value increase. There is also a need to conduct a rigorous experimentation to determine whether this stage can be retained. There are strong indications that this stage can survive the rigour of research.

5. Maturing

Similar to the norming stage of Tuckman's Stages of Team Development, this stage appeared to focus teams towards the project, and the specific pieces of information and knowledge that teams required from Google Assistant tended to be more targeted to specific aspects of the project. For teams that had no clear project, this stage tended to narrow down areas that might be pursued as possible projects. For teams that started off with a clear project, this stage deals with pieces of information and knowledge that progress resolution of some aspects of the project. It is also important to note that proficiency in use of these technologies provides a basis of how teams mature into real interactions with intelligent technologies as allies in creative problem-solving.

6. Deep learning

The human-machine collaboration will work even better when intelligent technologies move away from hard-coded knowledge and can extract patterns from raw data which means functioning in an unsupervised way. This is what is called machine-learning capability because it allows for tackling problems that entail knowledge of the real world which is informal, intuitive and subjective. Creative problem-solving goes beyond formal knowledge (known, established) and includes intersubjective knowledge that can be contextual and unique to certain people. Deep learning would require intelligent machines that can transform such input data that can be esoteric and informal into a slightly more abstract and composite representation in ways that could lead to the development of concepts hierarchies. Given that humans rely mostly on informal and intersubjective knowledge in problem-solving, the point of deep learning with smart machines would most likely occur at the intersection where smart machines can reason about statements in the informal, subjective language as humans bring their own informal knowledge into the equation. This will be the point where humans and smart machines generate intersubjective knowledge that allows for reimagination, which is a crucial element of creativity. Currently, smart machines can reason using logical inference rules or on the basis of the knowledge base approach which relies on formal knowledge; hence such learning is considered superficial because it is based on known, established knowledge. Deep learning, as an important stage in team development, would be achieved and observed, I posit, when the human-machine collaboration leads to reimagination. Value is often cocreated when things are reimagined. This is probably the most important stage of human-machine team development. As AI capabilities develop to make it possible for smart machines to function unsupervised, that is, on the basis of processing raw data and in similar fashion as humans who rely on informal, subjective knowledge and knowledge developed, over time, with others in particular contexts (intersubjective) to resolve problems, then deep learning that lead to creativity will be possible. Creativity is not merely about creating concepts hierarchies, frameworks and models for understanding reality. It is not also about making some ontological commitments rather is about reimagining and altering naturalistic and authentic contexts. It is about trying out things through multiple iterations, testing and refining. It is even about defying logic as its primary purpose is to seek pragmatic solutions to real problems and impact societal practices in ways that advance human conveniences. It requires smart machines with deep learning capabilities not as currently understood but as yet to be imagined.

7. Resolution

Given that the possibilities of a real deep learning between humans and smart machines remain constraint, this stage of team development remains imagined.

6. Recommendations and future direction of research

Given that university cultures remain rooted in practices and activities that are task-oriented and output-driven, investment on human and machine thinking would remain a major challenge. This challenge is exacerbated by the general marginalisation of creativity in the university plinth. It is thus suggested that more research be conducted which illuminate the potential benefits of mainstreaming human-human and human-machine creativity. More experiments with more advanced intelligent technologies would help shape the team development stages suggested in this chapter. The following areas of research are worthy of consideration:

1. More research on university cultures and their relationship with the development of staff and student creativity within the framework of human - machine collaborations

2. University management mindset shift towards AI and appreciating the future realities of society 5.0

3. More experiments to clarify and possibly refine the human-machine team formation stages

4. University investment on advanced IT and AI

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