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Internet of Things (IoT) and the road to happiness

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Abstract

Purpose – This study aims to provide a systematic review about the Internet of Things (IoT) and its impacts on happiness. It intends to serve as a platform for further research as it is sparse in in-depth analysis.

Design/methodology/approach – This systematic review initially observed 2,501 literary articles through the ScienceDirect and WorldCat search engines before narrowing it down to 72 articles based on subject matter relevance in the abstract and keywords. Accounting for duplicates between search engines, the count was reduced to 66 articles. To finally narrow down all the literature used in this systematic review, 66 articles were given a critical readthrough. The count was finally reduced to 53 total articles used in this systematic review.

Findings – This paper necessitates the claim that IoT will likely impact many aspects of our everyday lives. Through the literature observed, it was found that IoT will have some significant and positive impacts on people's welfare and lives. The unprecedented nature of IoTs impacts on society should warrant further research moving forward.

Research limitations/implications – While the literature presented in this systematic review shows that IoT can positively impact the perceived or explicit happiness of people, the amount of literature found to supplement this argument is still on the lower end. They also necessitate the need for both greater depth and variety in this field of research.

Practical implications – Since technology is already a pervasive element of most people's contemporary lives, it stands to reason that the most important factors to consider will be in how we might benefit from IoT or, more notably, how IoT can enhance our levels of happiness. A significant implication is its ability to reduce the gap in happiness levels between urban and rural areas.

Originality/value – Currently, the literature directly tackling the quantification of IoTs perceived influence on happiness has yet to be truly discussed broadly. This systematic review serves as a starting point for further discussion in the subject matter. In addition, this paper may lead to a better understanding of the IoT technology and how we can best advance and adapt it to the benefits of the society.

Keywords Internet of Things, IoT, Happiness, Well-being, Society, Technology

Paper type Research paper

1. Introduction

Internet of Things (IoT) can be defined into the conceptual understanding of a world of interconnected technological devices that cater to its environment and that are controlled primarily by users (Khaddar & Boulmalf, 2017). IoT services its users by providing people and their resulting devices with the ability to seamlessly interact with their environment while also providing a means for the automated collection of data through the use of sensors.

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The information received through such sensors provides devices collecting such data to alter its environment based on the established parameters the machine is built within the network that it functions in.

While the most basic understandings of IoT derive from consumer-centric benefits such as digital assistant, smart door locks and wearable devices, IoT provides further impacts in industrial, medical and governmental settings. Consider the interconnected nature of traffic control systems, related utilities, streetlights and transportation applications; such elements operate on "cyber-physical" environments and are controlled autonomously through interconnected devices on a network (DeNardis, 2020, p. 9). The world is venturing toward substantial connectivity, with an expected number of 50 billion connected products and around one trillion active networked sensors by 2022 (Olalere, 2020). In major cities all around the world, IoT technology interacts with social components to improve the efficiency of city services such as optimizing the use of energy, improving traffic flow and providing real-time information about the public transportation network. The advent of IoT is far reaching due to the significant impact it has and will continue to have on many aspects of our everyday life.

Since IoT is already a pervasive element of most people's contemporary lives, it is important to consider how we might benefit from IoT or, more notably, how IoT can enhance our levels of happiness. For example, while monitoring health with background applications, smart watches and other wearables were developed to make everyday life more efficient, adding value or even be a point of happiness for some people. World Happiness Report 2020 stipulates that in increased income rural areas, evolutions in technology and improved digital infrastructures not only achieve higher levels of diversity and accessibility but also experience average happiness levels that meet or even exceed that of large cities (World Happiness Report, 2020, p. 69). This serves to supplement the necessity for further technological development and research in the future and on an international scale.

The importance of technology, and subsequently, IoT, cannot be more stressed in the contemporary world. Should the capabilities of new and evolving technologies reach greater expanses, we can certainly observe and understand the explicit impacts it may have on happiness. As we are trying to emphasize a strict application of "happiness", in this review, it is important to understand what happiness means in this context. Further deliberations below on IoT and happiness will breakdown the importance of these two subjects while outlining necessary information that helps in connecting them together. As IoT is more acutely integrated into daily life, can we assume that people are happier when they are actively connected to one another and to every single thing around them? Understanding how we can fine-tune it in such a fashion that its benefits far outweigh its costs will provide the coming generations with more answers to contemporary issues in society, healthcare, the workplace and far more.

Because the combination of these two subjects, IoT and happiness, are not wholly explored in such an explicit manner, our intentions in this systematic review are to open up a plethora of new avenues for research opportunities in the fields. The hopes are that in the coming years, more research that explicitly explores the relationship between IoT and happiness will arise from this body of research. It will become growingly clear as readers explore this systematic review that the relevant literature found within this subject matter is sparse and varies in quality. The end goal would be to rectify the low number of literature found by firstly providing such a systematic review, which may then catalyze further research. As more research is done, relevant and higher quality research might expectantly develop as a result.

This paper begins by outlining a broad definition of IoT and the explicit usage of the term "happiness" in the theoretical background section. This will serve to preface the relationship between IoT and happiness while establishing the systematic reviews' thematic elements. Several articles from various journals that service this relationship will be used to make determinations on IoT's contemporary and future impacts on individuals and groups. Searches will be categorized based on various parameters to present the thematic nature of the publications, when the articles were published, and to what journal the articles belong to. The discussion section is divided into five themes interpreted from the articles used in this systematic review. These five themes are as follows: social, business, education, healthcare and workplace. These themes are specifically highlighted because they present the most apparent relationship between the usage of technology and an individual's or group's happiness. The conclusion section is divided into three parts: (1) any potential gaps and limitation in this field of research and where most work is necessary to aid the propagation of this subject matter, (2) any prospects and research that is expected to be done and (3) a summation of results and conclusions that can be made with the existing literature.

2. Theoretical background

2.1 IoT

2.1.1 Context. IoT can be broken down into its characteristic elements where the Internet and technological devices interact in such a fashion that communication is almost seamless and can be carried further through broader networks of communication (such as several devices interacting with each other over the same network or networks interacting with other networks over the Internet). With this we can understand IoT to be characterized through devices and technologies adhering to low-power functionality, low-bandwidth and low latency connectivity (Islam & Want, 2014), but it is likely better understood as to how we make inherent links to a network or environment engrossed with technological devices through wireless connections and for broad use. IoT also lays on a theoretical foundation of pervasive or ubiquitous computing. While its adoption is dependent on various social, economic, political and entrepreneurial factors, its intent is for people to become accustomed to a future where IoT is prevalent, "Smart devices, for example, smartphones . . . will be the primary interaction tools used by people in a connected environment including cars, homes, and workplaces" (Khaddar & Boulmalf, 2017, p. 138). With this, common devices such as phones, tablets and computers can likely serve as the primary devices with which people are able to begin interacting with their environment. IoT further expands into the usage of devices that control homes, appliances, medical equipment and other such devices with the prospects of connectivity to the Internet. In essence, devices that have a means of connectivity to the Internet and can be controlled through the Internet can be considered IoT devices because that is how IoT was intended to function.

2.1.2 History and contemporary uses. If we consider any devices with a means to connect to the Internet as an IoT device, most technology that surrounds our contemporary lives inherently share IoT qualities and are thus ready for use in all IoT spheres. Looking historically, IoT intrinsically shares the same fate as that of the Internet. Should there be no Internet to speak of, IoT as we understand it would not have been explored. While there are certainly examples of devices or sensors that have interacted along a network prior to the introduction of browsers (which catalyzed a wider use of the Internet), the Internet itself has broadly enhanced both the appeal and serviceability of IoT. We can conceptually understand IoT to be devices and/or sensors interacting with one another across a network or multiple networks; there is no denying that the upbringing of the Internet to what we have today directly coincides with the development and salience of IoT. It can then be said that IoT is all encompassing in the realm of wireless technology. Look at our very own smart devices and how they interact with various networked and wireless elements and devices to construct an idea of IoT. Devices like smart hubs and smart speakers, and concepts such as smart homes, smart cars, and sensor related environmental alterations in public, private and workspace environments immediately come to mind as the most pertinent examples of IoT integration in our daily lives.

2.2 Happiness

Happiness as a biological construct is difficult to quantify given its subjectivity. An important element of this systematic review will be in describing the association of happiness in conjunction with IoT. One pervasive distinction that needs to be made is that "Happiness", as is generally understood, can hold a variety of meanings. This can extend from the individual self to the entire group or collectives of people. Happiness is the colloquial term used to describe a scientifically positive psychological feeling known as one's subjective experience of well-being (SWB) (Diener, 2000, p. 34). The modern definition of happiness consists of two components: experiencing positive and pleasant emotions like pleasure, contentment, joy, and love, and having a sense of satisfaction with the way of progressing toward one's life goals (Lyubomirsky, 2008). Accordingly, people experience subjective well-being when they are experiencing more pleasure than pain, when they feel many pleasant emotions and a few unpleasant ones, when they engage in exciting activities and when they are generally satisfied with their lives (Diener, 2000, p. 34). In light of this definition, happiness is inherently subjective because it is an individual's affective and cognitive evaluation and assessment of their own lives (Diener, 2000). Happiness is people's personal experience of well-being, so it varies between individuals, and no one can best describe these experiences, but those who experienced it themselves (Ferrer-i-Carbonell, 2002). The existing positive psychology literature is rich with publications hypothesizing what factors and elements affect happiness. Among this corpus of scholarship are studies examining the effect of technology on happiness. Some studies have concluded that technology and especially the Internet can affect happiness positively as well as negatively, but that greatly depends on how we use technology (Mochón, 2018).

When discussing IoT and happiness, we consider happiness levels to be altered based on perceived levels of increase in satisfaction, well-being, productivity and security. As aforementioned, happiness is a metric that is difficult to quantify at an explicit level. Proxies to happiness will act in lieu of happiness. The term 'productivity' or 'productive' is used in regard to happiness and its impact on work. Collaborative research conducted by Said Business School in Oxford University and a British tele-company firm, BT determined in a study that an observable 13% increase in productivity occurred when workers were happy (University of Oxford, 2019). If we understand happiness to be in a state of positive psychological well-being, terms such as 'well-being' and 'health' can also be used in reference to happiness, being that "... the results of existing research point very strongly to links between [psychological well-being], life and health outcomes'" (Johnson, Robertson, & Cooper, 2018, p. 7).

All this is prefaced so that this systematic review can comprehensively allude to the construct of happiness. In this paper, we look at happiness as the current state of emotion where a person would be able to clearly state whether he/she is happy or unhappy. In other words, happiness is a reflection of people's feelings. While the term "happiness" may not explicitly appear in the myriad of the observed literature, other terms can act as proxies that connote to happiness on an individual or group level.

3. Search and review methodology

Prior to delving into determining relevant keywords and using search engines, a couple of key preliminary parameters were established to refine the exploration of this subject. Since the systematic review centers around IoT and its subsequent associations with happiness, limitations to how these subjects are approached were implemented. This entailed a movement away from the literature that strictly elaborated on just "IoT" or just "Happiness". The literature observed as a result had to primarily deal with how IoT had some relational impact on individuals or groups with respect to the overall increase in their purported happiness. The term "group" simply implies a situation where a variety of individuals are observing the impacts of IoT. This can be in households, workplaces, hospitals and any theoretical or practical scenario where several individuals are observing the impacts of IoT in their respective environments. Furthermore, should the literature deliberate on how IoT is used to enhance the "well-being", "satisfaction" or "productivity" of individuals or groups, this would justify the parameters of establishing IoT's impact on happiness.

One other key parameter set was determining the time frame of the literature to be used. Through basic observation in our lives, technology has only become more integral to how we operate in society. As a result, technology continually evolves year-by-year. We believe recency is not only important but also relevant due to how quickly technology has enamored daily life and because of how fast technology can become outdated. The year 2014 seems a logical determination for meaningfully exploring IoT infrastructure in the modern era due in part to our growing relationship with technology but also because of the following reasons: (1) Cisco's CEO John Chambers expressed the market valuation of IoT at $1.9 trillion at the Consumer Technology Association in 2014, signaling commercial and industrial movements to produce IoT devices and products (Ravindranath, 2014). (2) While substantial in impact though not innovative in theory, particularly inexpensive and power-efficient chips were developed by the likes of Intel, Texas Instruments and Qualcomm (Mims, 2013). This further democratized people's ability to connect anything to the Internet with the added advantage of lower latency and lower bandwidth requirements, a primary characteristic of IoT technology (Islam & Want, 2014). (3) The year 2014 was also a significant year for smart hubs and homes with Amazon releasing the Amazon Echo, a personal assistant device that could connect to the Internet to find information when spoken to Johnson (2019). More importantly, the Echo device could be used to control other smart devices on a shared network, providing the user with unparalleled control of devices in their vicinity. This harkened a scramble for other companies to produce competing products in the smart home/hub market.

In this study, we follow the systematic review process proposed by Cronin and George (2020) because we are exploring different work and findings that are not necessarily using quantitatively comparable constructs. We start by determining the purpose and types of studies suitable for this study before performing an in-depth literature review. We then perform thematic synthesis of the findings by integrating themes that support the goals of this study. A flowchart of our research process is shown in Figure 1.

3.1 Search engine and results

The search engine used was WorldCat (https://aus.on.worldcat.org/discovery) because it provides access to many databases worldwide. ScienceDirect (https://www.sciencedirect.com/) was also used because it served the same purpose and provided journals with a more focused set of articles and papers that pertained to technology. The technical search terms to be used should combine the aspects of IoT and Happiness. The first search term should include IoT as a Keyword, so we have kw ("Internet of Things" OR IoT). The second search term should emphasize on happiness. Because the term "happiness" is not typically and explicitly stated in several articles, other terms that allude to happiness, such as "satisfaction", were used as proxies. To avoid missing out on papers that did not include our terms in the title while also avoiding adding this specific parameter to keyword searches (as this would greatly expand search results far beyond a manageable size), the search engine was set to scan the terms in the abstract only. This resulted in the second search term being ab: Satisfaction OR Happiness. The final search term for WorldCat was as follows:

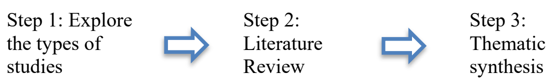

Figure 1.
Research process flowchart

kw:("Internet of Things" OR IoT) AND ab:(Satisfaction OR Happiness)

Unlike WorldCat, ScienceDirect does not have the functionality to search by abstract. As a result, the final search term for ScienceDirect was as follows:

("Internet of Things" OR IoT) AND (Satisfaction OR Happiness)

Three parameters were established for the review of the existing literature. They had to be in English, scholarly and published between 2014 and 2020. The searches were done in August 2020 and resulted in 524 and 1,977 hits for WorldCat and ScienceDirect, respectively.

3.2 Prescreening and the screening process

The prescreening algorithm started by filtering the papers through the title. Out of the 524 search results for WorldCat, 101 papers passed the prescreening process. Out of 1,977 hits for ScienceDirect, 98 papers passed the prescreening process. Next, they were rigorously screened by going through the abstract of each paper to determine relevance. This implied that the abstract had to contain content that broadly pertained to IoT and its impacts on satisfaction and happiness, which resulted in 42 papers from WorldCat and 30 papers from ScienceDirect. Due to the limited literature available, and the limited number of research papers available, no geographic boundaries were taken into consideration. Since two search engines were used, the removal of duplicates was necessary. Resultantly, six papers from ScienceDirect were removed. Next, with a full read through, we further removed papers that were not sufficiently relevant to the subject matter which resulted in 38 and 15 articles for WorldCat and ScienceDirect, respectively. The final step was to categorize the papers based on different themes which alluded to how IoT impacts different sectors of our lives (Khaddar & Boulmalf, 2017; Fischer, Righi, Ramos, Costa, & Rodrigues, 2020; Mochón, 2018). This was done using content analysis where different keywords were set to classify the literature into themes. The keywords were selected based on the common words used to describe each theme as found in the literature. For example, the healthcare theme had *healthcare, hospital, patient* and *doctors* as keywords. If a paper possesses one of those as a keyword or made frequent mention of it, this resulted in the paper being categorized as healthcare. Table 1 shows the set of keywords used for the categorization of themes. Figure 2 shows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) screening process.

3.3 Results

Based on the screening process, a few themes were explicitly present while conducting the exploration of the literature in this subject matter. At this stage, the literature was more discreetly scrutinized for relevance. Resulting papers were categorized into their respective themes and used to elaborate on IoT's influences on the determined themes with respect to happiness. The articles are resultantly classified into different themes, *Social, Business, Healthcare, Education* and *Workplace*. Table 2 gives a brief definition for each theme. A complete list of all the 53 papers, categorized based on thematic nature of the publications,

Theme	Keywords
Social	Smartphones, Smart Devices, Smart homes, Smart Hubs, Wearables, Networks and Sensors
Business	Business, Supply Chain, logistics, E-commerce, E-retail, Inventory Management and Operations Management
Healthcare	Healthcare, Hospital, Patient, Practitioner, Doctor, Assisted Living and Medical Facility
Education	Education, Students, Classroom and Teaching
Workplace	Workplace, Employees, Human Resources and Smart Assistants

Table 1. Keywords and themes

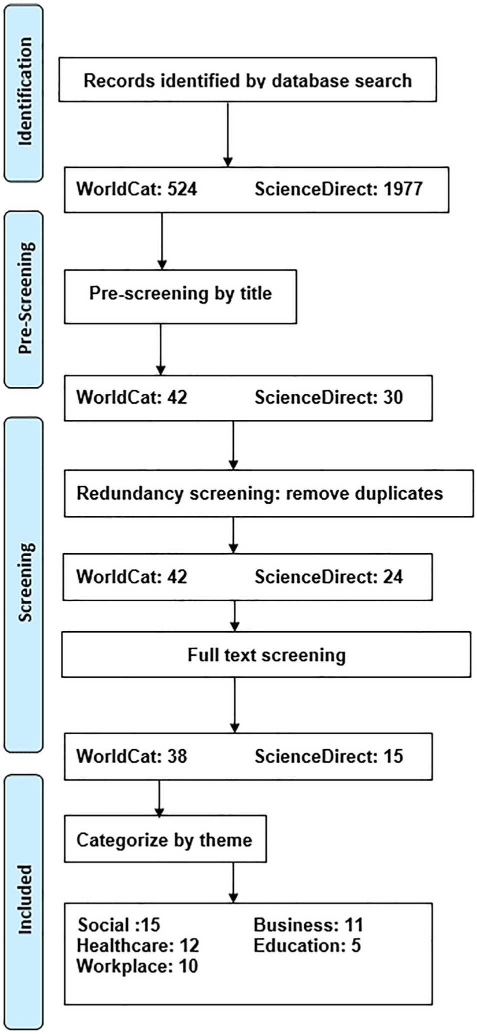

Figure 2.
PRISMA flow chart

when the articles were published, and to what journal the articles belong to can be found in Appendix.

4. Discussion

In this section, findings of the study are discussed in more detail. The discussion is organized into the five themes identified previously and is further divided into subcategories of relevant information related to IoT and happiness within each theme.

4.1 Social

The Social theme pertains primarily to how IoT influences or impacts happiness on a societal level. This may be further pertinent to impacts on a person or a group, such as families and

Theme	Definition
Social	The social theme denotes applications of IoT on a broad spectrum. This is inclusive of devices that can be accessed and/or used in public spaces and houses such as smart devices, smartphones, smart hubs, housing appliances and wearable devices with connectivity to a network or networks
Business	The business theme denotes how IoT can affect daily business processes, mainly through the utilization of sensors. This is integrated through e-commerce, logistics and supply chain that seamlessly communicates between different entities to ensure an efficient transition of products from raw materials to products on the shelf
Healthcare	The healthcare theme denotes applications of IoT in hospitals, healthcare facilities, and in-home assisted living facilities. This is inclusive of sensor devices, wearable and otherwise, that relay medical information to practitioners as well as data collection algorithms and applications that can seamlessly be shared between practitioners and patients
Education	The education theme denotes applications of IoT in classroom and educational facilities. A prominent example would be a smart board. This includes the altering of classroom environments and collecting of information using sensors and smart devices to improve the quality of teaching and students' learning experiences. It also includes the integration of IoT in educational curriculum
Workplace	The workplace theme denotes the impact of IoT applications in a workplace on various levels starting from front-line employees up to the management and human resources. It addresses the potential of this interconnected network of devices that functions together to increase the overall productivity, satisfaction and improve the user experience

Table 2.
List of themes and definitions

places of public gathering. IoT typically operates on shared networks and takes into consideration the different devices that operate on these shared networks. The term "shared networks" simply alludes to the idea that several devices with an Internet connection can communicate with one another on a network that they are all hosted on. The network can further be manipulated by the end user to successfully task devices to operate simultaneously or receive feedback from the end user to achieve a goal. The societal impacts of IoT cannot then be overlooked. As it expands into more facets of our lives, frameworks to invest, operate and educate on the benefits of IoT need to be set in place. Since IoT occupies a pervasive position within the lives of all people in the future, understanding cultural impacts, the alteration of productivity (Shim, Avital, Dennis, Rossi, Sørensen, & French, 2019) and people's overall satisfaction and security with such systems becomes a primary concern (Shin, 2014).

4.1.1 Applications in the common devices. Within the common devices of everyday use, the functional merit of IoT in the household is often applicable. IoT can be used as a central concept for operating home efficiency management systems (HEMS). These systems allow for the end user to control various IoT devices within the household with the explicit purpose of minimizing energy consumption through developing an optimization model (Lin, Yang, Pan, Zhang, Wang, & Fan, 2019). This optimization model takes into consideration the energy-saving parameters of the end user and automates the minimization of energy consumption in household appliances across a network. The system is capable of saving considerable amounts of energy while ensuring customer comfort and satisfaction (Lin *et al.*, 2019). HEMS have also shown changes in the degree of comfort received by residents under such a system. The system itself operates using sensors communicating through a network that explicitly alters indoor conditions to suit the preferences of a household. A study conducted in three Japanese households over 12 days displayed promising data with respect to changes in energy consumption and indoor comfort (Matsui, 2018). The study concluded that HEMS reduced energy consumption by 5.15% and increased indoor comfort by a further 16.4%, presenting more tangible results to the impacts of networked sensors in enhancing the livelihood of people (Matsui, 2018). One other research with an emphasis on crowd-sensing technology found that adapting an indoor comfort management system, namely the ComfortSense project as the article stipulates, can show marked improvements in the comfort of building occupants while reducing the overall energy consumption of heating, ventilating and air conditioning (HVAC) systems (Cottafava, Magariello, Ariano, Arrobbio, Baricco, Barthelmes, & Vernero, 2019).

Another method of similar reductions of energy consumption can be found in a constrained particle swarm optimization based residential consumer-centric load-scheduling method. The method here entails a monitored system whereby home appliances, in similar fashion to the previous application, are optimized for energy consumption based primarily on the end users' daily habits. The effectiveness of this method is based on demand response or where the user alters their energy consumption based on energy costs, and this method effectively limits energy consumption by nearly 14% (Lin & Hu, 2018). Security may also take equal precedence to efficient energy consumption as it provides the household with a more stringent level of security through the deployment of sensors. Such sensors can be used within the household to detect security alerts such as smoke, fire and water leaks. The collected data not only becomes useful for residents but also for responders who can react faster to alarms, thus increasing levels of satisfaction and peace of mind for the residents (Makhluf, 2017). IoT products further enable a degree of data collection, specifically in estimating the number of occupants a household has, which allows for further analysis of household and resident needs based on the metric of daily occupant activities (Kim, 2019). In a similar fashion, the advent of a health smart home (HSH) may also be taken into consideration. An HSH operates through the use of IoT image capturing sensors that can pick up facial expressions or, more specifically, emotions. With patients and the elderly opting for in-home healthcare, this type of sensing technology can be advantageous for caretakers trying to provide responsive care for patients in an effective and timely manner through the recognition of emotional states (Mano, Faiçal, Nakamura, Gomes, Libralon, Meneguete, & Ueyama, 2016).

4.1.2 Applications in wearable technology. Further IoT functionality can be found in the broad servicing of people's well-being and health. The use of wearable technology can be optimized to analyze the mood of users and further provide them with specialized remedies to rectify negative habits and moods. An innovative IoT-based well-being recommendation system called IAMHAPPY proceeds to tackle this very objective using an online knowledge repository for remedies to varying user discomforts. It actively analyzes user discomfort while providing such remedies that can be used to enhance user happiness and well-being (Gyrard & Sheth, 2020). The ongoing use of wearable technology can further provide large sums of data from a variety of subjects and on a broader scale to quantify values associated with happiness. One such article suggested the large-scale integration of wearable technology called Wearable Happiness Meter (Yano, 2015). This wearable technology can be used to determine the productivity and well-being of people, be it in workplaces, public venues or at home. It helped to observe employee happiness through a spectrum of values fed into wearable devices that produced data on what alters or enhances employee well-being. It further establishes the use of such sensors in public transport and healthcare, where IoT systems can be optimized based on data collected from the wearable technology (Yano, 2015). The primary goal here is to enhance user well-being and satisfaction. Another application of wearable technology can be found in wearable sensors, namely the Emotional Smart Wristband integrated with an ambient assisted living platform called iGenda (Costa, Rincon, Carrascosa, Julian, & Novais, 2019). Such a system derives its use from elderly facilities, similar to the aforementioned HSH, whereby sensors detect emotional distress, alerting caretakers with useful information that could be used to improve the lives of those living in such assisted living facilities (Costa *et al.*, 2019).

4.2 Business

IoT has dramatically impacted business applications and its operations specifically in the following industries: utilities, transportation and logistics, consumer electronics, public sector/smart cities, smart building and industrial automation (Shim *et al.*, 2019). In the general context of business, IoT can be divided into two types: consumer IoT and industrial IoT (Shim *et al.*, 2019). Consumer IoT includes common devices for everyday use such as smartphones and smart watches. Industrial IoT on the other hand involves the transformation in the services provided by the business and government such as smart traffic lights. A study was conducted on Chinese e-retails using a triadic model to achieve a greater overall customer satisfaction in the era of IoT. Results from data of 148 Taobao e-retailers showed that hard and soft infrastructure have a positive influence on flexibility which increases customer satisfaction (Yu, Subramanian, Ning, & Edwards, 2015). Also, industries such as tourism and hospitality are expected to improve their performance and efficiency with the adoption of IoT by bringing better ways of serving customers and improving the management. Features such as personalized hotel rooms, voice-based interaction, integration with mobiles and body sensors are expected to raise customer satisfaction (Car, Stifanich, & Simunic, 2019). Management of these features will help reduce their cost by having better inventory management systems, automation and monitoring, maintenance, and energy saving methods (Car *et al.*, 2019). Another article takes into consideration an IoT-based-E3-values business model which improves the overall business process by predicting customers' requirements, the core elements of business, the value proposition of a company and the channel distribution (Shoukry, Khader, & Gani, 2019). This model was tested and proved to be successful as it improved the overall business efficiency.

4.2.1 Supply chain and logistics. An IoT outbound logistics knowledge management system was created for the purpose of monitoring environmentally sensitive products (such as electronics which wear out in high temperatures or are damaged in humid environments) for outbound logistics and predicting the quality of the goods delivered. This system aims to detect environmental conditions and further manage the outbound logistics of the process. The IoT systems involve sensors which can detect temperature, humidity, movement, barometric pressure and light exposure. Such a system was designed to ensure the highest quality for goods. Results show that this system increased efficiency as well as reduced time required for planning, which caused an increase in customer satisfaction (Yuen, Choy, Lam, & Tsang, 2018). Another IoT-based risk monitoring system was designed to control product quality and occupational safety risks in cold chains by wireless sensors that collect information about the conditions of the environment; this information is applied to a product quality degradation model in the cloud database. A fuzzy logic approach is then used to evaluate cold-associated occupational safety risks of the different cold chain parties considering specific personal health status. Such a system can ensure that products will be handled within the desired conditions, appropriate temperatures, humidity and light intensity. It can also reduce occupational safety risks from happening (such as cold associated injuries), thus increasing worker satisfaction and operational efficiency (Tsang, Choy, Lam, & Yuen, 2018). Another sensor related article discussed sensor-based measurement containers connected to an android application. They are added to the system to help manage household commodities, by sensing the quantities bought and notifying when the reorder point is reached by those commodities. Furthermore, the dispatching operations were dramatically improved through the use of such IoT applications (Kaur & Kaur, 2018). Similar research showed how IoT was used in dispatching seamless coordination between customers, order-picking robots and cloud technology. Additionally, algorithms that consider IoT input variables to find the best and fastest route to formulate an intelligent order dispatching system resulted in enhanced customer satisfaction, proving to outperform the traditional dispatching methodologies (Wang, Lim, Zhan, & Wang, 2020). IoT devices such as camera networks, smartphones, and smartcard chips are used to manage demand, whereas radio frequency identification (RFID), Bluetooth, and global positioning system (GPS) are used to manage supply. IoT provides opportunities to enable firms to perform more efficiently or enhance firms' capabilities by creating new opportunities (Caro & Sadr, 2019). Another study shows the impact of IoT on the inventory management of aircraft spare parts. Results indicated a reduction in inventory cost and an improvement in service availability (Keivanpour & Kadi, 2019).

4.2.2 E-commerce. The article, *Achieving Service Process Excellence with Connected Customer* (Yerpude, 2019), addresses the importance of gathering information from either the purchase history of customers or their online behavior and shopping patterns. This vast collection of processed data helps businesses target their audience base by delivering the right products and services to interested potential customers. Customers' portfolios are created on a customer relationship management (CRM) platform where their purchase history and interests are then analyzed to offer the best online shopping experience through implementing the most suitable marketing strategies (Yerpude, 2019). Although most businesses were skeptical about investing money in these uncertain advancements, only the ones who overlooked the short-term profits and focused on the long-term were able to survive and become pioneers in their market. Further, with the partnership of some augmented reality (AR) vendors, a smarter and more effective user interaction experience can be achieved. It offers customers higher usability and greater satisfaction with AR-interactive shopping. Hence, customers, for example, can try on outfits and see how suitable it is before buying it (Jo & Kim, 2019). First movers' retailers that invested in technological advancement in their user experience tend to have a competitive advantage over their rivals in the e-commerce world. The power of data interchanging between smart devices and then processed through powerful algorithms has enabled businesses to unveil useful information that helps build agile and powerful strategic plans that dramatically reduce expenses, increase efficiency and the overall user experience.

4.3 Education

The education sector was enhanced in many ways by the adoption of IoT. For example, the IoT provides an approach to designing a Big Data system to collect, integrate, analyze, process, store and visualize data from many sources into one big smart library for educational purposes (Simović, 2018). Such a system anticipates users' needs by providing content from various sources, resulting in greater student long term satisfaction. The system is also economically beneficial for the educational institution. Another study relating to libraries was conducted in the United Arab Emirates through surveys handed to 120 library users of universities and colleges in Dubai to study the different possible IoT integrations in libraries (Alagumalai & Natarajan, 2020). Results showed that IoT would ease the access to libraries and its resources while further improving recommendation and location-based services. It also showed that students were satisfied with the performance of IoT based libraries (Alagumalai & Natarajan, 2020). Considering the constant evolution of education and how it can be furthered by effective technological integrations in academic institutions, a Science, Technology, Engineering, Arts and Mathematics (STEAM) education program was developed with the use of an IoT product, CloudBit, to aid first grade students in developing their creative processes and problem-solving skills. Results from surveys found that students had a high level of satisfaction and participation with respect to the STEAM program (Tae, 2017). Moreover, increases in interest were found for the subjects of mathematics, science and technology as well as positive changes in students' care for such subjects (Tae, 2017). A study that investigated smart classroom systems conveyed a system that measured the lecture quality through smart devices for the purposes of analyzing the classroom environment. Results indicated that temperature, humidity, CO_2 levels, lecturer voice and intensity of the motion of lecturer's hands are factors associated with determining student's satisfaction in a lecture (Uzelac, Gligorić, & Krčo, 2018). Moreover, a proposed implementation of IoT infrastructure for medical education called the IoT-based Flipped Learning Platform (IoTFLiP) was evaluated (Ali *et al.*, 2017). IoT would serve to elevate students' educational and practical experience by providing developed medical cases and supporting the flipped learning environment (Ali *et al.*, 2017).

4.4 Healthcare

Healthcare rose as a prevalent part of this papers' exploration because its use seems to offer an unprecedented level of extensive patient care that goes beyond the typical realms of conventional communication channels between medical practitioners and patients. This exploration finds that while there is abundant literature on how IoT is meant to function in the medical world, there is little that explores a greater discourse on broader integration. The merits of this theme are certainly huge and may be one of the most compelling prospects to look out for when deliberating on the future of IoT and its influence on happiness. The very same concepts of security and privacy will certainly exist in future literature. The need for extensive discourse on new medical technology with integrated and low-latency methods of diagnosis has never been greater. For example, the benefits of a healthcare system where patient data are funneled in a timeless manner to the appropriate agents, where communication between different medical agencies and institutions is seamless and where the execution of medical innovation is quickly taking precedence.

4.4.1 Applications in sensor technology. The most significant use of IoT that can arise in the healthcare industry may come from the application of wearable devices used to evaluate and analyze a user's biometric signs. Such sensors would certainly advantage medical personnel seeking a streamlined reception of patient data through cloud servers that receive and collect the data for distribution to other authorized personnel. The functional applications of these wearable sensors may best be exemplified in managing quality of life for elderly patients as well as patients suffering from chronic illnesses. Such applications also provide the means for medical personnel to send patient data to other more reputable institutions and practitioners who may aid in providing greater feedback, second opinions and input regarding patient data (Prasad, Chiplunkar, & Nayak, 2017). Since wearable sensors provide a profound means to both the attainment of active patient data as well as the delivery of such data, the safe harboring of patient data should take precedence too (Bakashi, 2018). This all categorically falls into growing divisions of healthcare fields such as eHealth, digital health, or the Internet of Medical Things (IoMT). All terms allude to the concept of using technology and IoT for better enhancing the quality of care provided by medical practitioners for their patients. The inherent functionality of related devices is meant to service interoperability and interconnectivity where machines, devices, sensors and people can communicate over the Internet to discuss medical matters, provide insight on cases and evaluate patient care all while providing connectivity between a patient and medical practitioner through the use of IoT (Fiaidhi & Mohammed, 2018). In fact, one such evaluative study conducted using wearable sensors for both patients and medical practitioners revealed the behavioral aspects of communication between the two parties. While the sensors were used inherently to collect various data points about the interactions between patients and practitioners, the study concluded that patients were more satisfied when they were kept in regular communication about their conditions and when practitioners remained within close proximity (Stefanini, Aloini, Gloor, & Pochiero, 2020). The evaluative methods of these sensors provided further insight into what elevates patient satisfaction and well-being.

4.4.2 Applications in resource management. IoT may yet serve its most functional purpose in healthcare through its use in the worlds' global pursuit to eradicate the COVID-19 virus. There are medical devices that can be connected through the Internet, automated systems of detecting infections, screening patients and warning personnel of necessary precautions for newly admitted patients. These can serve to better help all medical practitioners proactively manage an influx of patients while maintaining quality of care (Singh, Javaid, Haleem, & Suman, 2020). This may be most critically observed in cities with high populations or where smart devices are broadly available. An important aspect of the healthcare industry relies on the management of resources to effectively tackle scenarios from routine hospital operations to pandemics. One such factor that IoT will certainly help hospitals deploy is in using remote systems of monitoring, tracking and robotic care. As hospitals may begin adopting smarter applications and infrastructure to conventional hospital operations, resource allocation and its impacts on patient satisfaction and well-being are taken into consideration.

An algorithmic system for resource allocation called the Maximum Resource Allocation (MRA) would act in conjunction with IoT to determine a balance between the satisfaction factors found in this algorithm: (1) patient satisfaction, which derives values from how long a patient waits and the level of care they receive, (2) owner satisfaction, which derives value from how much profit and revenue is being made, and (3) medical resources satisfaction, which derives value from changes in wages and amount of work given (Oueida, Aloqaily, & Ionescu, 2018). The objective here is in a balanced allocation of medical resources that is optimized for all aforementioned satisfaction factors. With this, applications of IoT based fog computing can be used to better optimize the timely service of healthcare in remote locations through interconnected healthcare networks in conjunction with 4G and 5G infrastructure worldwide (Mani, Singh, & Nimmagadda, 2020). Another avenue for IoT's impact on patient satisfaction may be in the revamping of computing infrastructure in healthcare facilities to better manage the allocation of medical practitioners and unused hospital rooms. One article prefaces the use of a model called ElHealth which takes predicative data of IoT sensors in hospitals to manage hospital resources more effectively (Fischer *et al.*, 2020).

4.4.3 IoT adoption in healthcare. Another consideration regarding IoT adoption may then relate to the adaptability of both patients and medical personnel to an IoT environment. The preemptive goal of developing an application of IoT in healthcare derives from a precondition is as follows: should user satisfaction not be achieved, the adoption of IoT and subsequent increases in e-loyalty to the system stand to fail (Martínez-Caro, Cegarra-Navarro, García-Pérez, & Fait, 2018). To tackle the concerns of patients who will make use of IoT or more specifically the IoMT related services and devices for the management of their well-being, a great deal of work needs to be done to practically evaluate the human-centric flaws that may arise out of the adoption of IoT and its purported improvements on patient well-being. The particularities of using the system are noted as a result of conducted studies on the concerns of users such as the types of learning required for IoMT-based systems alongside security and privacy concerns (Kotronis *et al.*, 2019). Ultimately, securing patient confidence in IoT should be a priority. From a practical standpoint, the introduction of IoT services in healthcare may subsequently begin through integrating a patient's mobile devices into the process. Most patients will carry some device that can connect to the Internet; the objective here is in the provision of a program used by both medical personnel and patients in order to streamline communication, and more importantly, provide more direct remedies to discomfort.

A study was specifically conducted on the merits of mobile health applications where 88 postbreast cancer patients were provided a 12-week exercise program on their smartphones. Results showed that approximately 80% of patients regarded the mHealth program as helpful in managing well-being, while also suggesting a need for even greater reduction in feedback delivery time to increase patient satisfaction and well-being (Lee *et al.*, 2018). One other similar model in development may be found in the CONSIGNELA project, a project specifically devised to tackle elderly and Parkinson disease patients' adherence to prescriptions. Devices such as tablets and other related touch screen interfaces are used in conjunction with a collaborative app used by both patients and medical professionals to streamline communication and effectively monitor adherence to prescriptions (Wanderleya *et al.*, 2018).

4.5 Workplace

The IoT revolutionized technology in the Web 2.0 era as its impacts have been far reaching. The workplace is certainly not an exception to this case. IoT stands to alter both the infrastructure and processes of any system it is integrated in. One such challenge that IoT will continue to face is in its adoption, especially in the workplace. As a result, researchers are keen to resolve questions on how employees in the workplace will react to IoT applications. Will it have a direct impact on their well-being? What costs are present? Could it enhance workplace productivity and efficiency? If so, could a happier workplace environment be achieved using IoT? Considering these questions, future research needs to acutely answer these questions as IoT adoption becomes a regularity. Of course, the most prominent applications may be in how it might integrate with daily routines in the office. This would include answering questions, processing data, controlling the surrounding environment and participating in daily decision-making processes. In this paper, employees in an organization will be segmented into the following groups: front-line employees, management and human resources. Understanding the potential that the IoT applications will have in the workplace is important as it enables employees to gain insight into the effectiveness of the systems they manage and its effect on them in return.

4.5.1 Front-line employees. Front-line employees' daily tasks may generally be repetitive, time consuming and exhausting. This can potentially prevent employees from working on more important tasks that require critical thinking, which may lead to a reduction in productivity. Over time, employees undergoing repetitive tasks might feel overworked and underappreciated, consequently affecting their work morale. However, considering IoT and its propensity for utilizing an interconnected network of devices, the advent of dramatically increasing productivity and improving the overall user experience should come into contention. One study evaluates the provision of a voice-enabled smart watch to employees that would be equipped with biometric sensors and access to the workplace network of other IoT devices. Beside the wide range of commands that commercial smart watches such as Siri and Alexa are programmed to act on, studies have proven that data from biometric sensors integrated can increase the potential of what these watches can do when connected to a full network of other smart devices (Nižetić, Pivac, Zanki, & Papadopoulos, 2020). In the study, the smart watches were programmed to utilize the data from its user to achieve a more personalized indoor environment that is most suitable for the user. In a smart workplace, smart watches will use the biometric data collected to modify the office temperature and lighting to best suit a user's needs. From a social point of view, it will help reduce physical stress on the user's body and eliminate many potentially serious, disabling work-related disorders. The smart assistant will alert the employee of any health risks after processing any abnormal biometric activity from the device, which if allowed by the user, can be shared with medical practitioners to provide medical advice (Gregori, Papetti, Pandolfi, Peruzzini, & Germani, 2018). Furthermore, in an interconnected network of smart devices, smart watches will be able to complete simple repetitive tasks such as sending emails, recording meeting minutes and even set meetings with mutual users' availability when requested. For example, after a scheduled meeting, the smart watch will be able to calculate the time needed for the employee to reach back to the office so that it will modify the office temperature and lighting to best suit the employee based on real-time biometric data (Martens, 2017).

4.5.2 Management and human resources. With all the information captured and gathered by smart assistants and other IoT devices in the workplace, Big Data systems can certainly be used to analyze employee strengths and weaknesses, evaluate overall employee satisfaction, identify top performing and underperforming employees and develop means to boost employee motivation and engagement (Kumar, 2016). Additionally, historical and current progress records of the company's projects collected by smart devices will empower managers to make strategic decisions that will be supported with real-time data and statistics. In a conducted study to investigate the impact of IoT implementation on firm performance, the results revealed that IoT implementation has a positive impact on financial performance and enhances return on assets (Tang, Huang, & Wang, 2018). This shows that organizations and companies can cut on operational expenses and save the company from falling into risky projects. Organizations can do this by augmenting in-depth analysis of collected workplace data alongside the utilization of external applications and data from credible sources online to generate a comprehensive assessment of the workplace prior to decisions. Moreover, through cognitive analytics, management will approach the transformation of organizations, people and systems to generate insights and create shared values (Osman, Anouze, Irani, Lee, Medeni, & Weerakkody, 2019). Analyzed data optimization will not only be limited to assist in strategic decision-making processes but might also assist in talent recruitment. This might be achieved by smart assistants suggesting the set of skills required for a vacant position in the firm by analyzing historical data from the tasks worked by former employees. IoT systems would then be able to establish a set of skills needed for specific positions in the company, which will greatly help in allocating the right candidate for the job (Ren, Hu, & Jain, 2016). Full optimization of analyzed data can dramatically lower a new employees' learning curve as it will provide all collaborative shared historical data that might be missed during typical handovers.

Moreover, information about the performance of the employees in the company and their satisfaction statuses collected by smart devices will be passed on to the human resources department for further analysis. Analysis of the information will provide insights into the current happiness meter within the firm. IoT will help the human resources department establish a fair, collaborative and adaptive environment for employees which will increase the satisfaction level of individuals and the productivity level of the organization.

4.6 Summary

Figure 3 below summarizes the discussion of IoT and happiness in each theme. One common factor in the discussion is concern over privacy and security. It was found that from a social perspective, users value the availability and security of IoT products and services the most. One such avenue to availability can be achieved through data generated by ensemble learning that is attached to a recommender system (Barbin, Yousefi, & Masoumi, 2019). This system generates recommended IoT products and services for users based on personal profiles and preferences. As such, the IoT devices must greatly preface a superb emphasis on security and privacy. Manufacturers must adhere to strict regulations that disallow the monitoring of IoT devices from malicious parties while still providing the user and subsequent IoT devices with ample and useful data collection for the optimization of IoT environments. Advanced encryption methods like end-to-end encryption become vital assets in the arsenals of manufacturers to ensure a

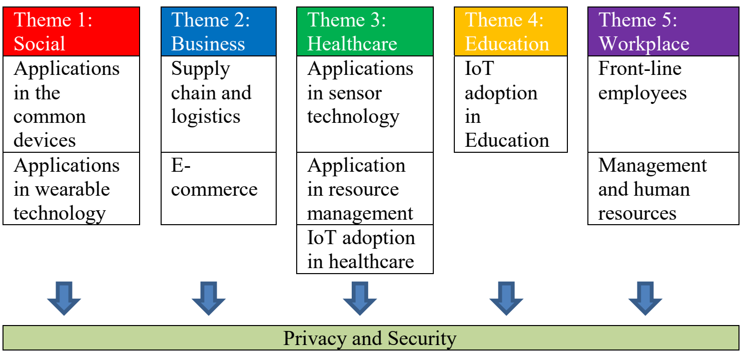

Figure 3.
Summary of discussion

comfortable level of privacy and security. This is elaborated on in the conception of a customer trust model that engages manufacturers with the likeliest requirements to providing a safe IoT experience for users (Khan, Aalsalem, Khan, & Arshad, 2019). Further, within the realms of software, software engineers tend to focus on interoperability and modifiability but not privacy issues. The Privacy by Design (PbD) framework provides systematic guidance to aid software engineers to create privacy-aware IoT applications. Results showed that awareness for privacy concerns in IoT applications has increased for software engineers (Perera, Barhamgi, Bandara, Ajmal, Price, & Nuseibeh, 2020). More stringent protocols for privacy and security are warranted as a result. With the increase in IoT devices around the world and the prevailing threats of data leakages or breeches, these matters become more salient because an integrated standard of security and privacy is not fully realized yet. The derived issues of scalability in the means to secure IoT adoption and subsequent increases in confidence on the part of potential IoT users require further deliberation should IoT seek greater adoption moving forward (Sicari, Rizzardi, Grieco, & Coen-Porisini, 2015).

Additionally, IoT has been shown to improve efficiency, quality and cost metrics; however, potential security related vulnerabilities preclude it from being recommended for all applications (Ramsoomair & Kolb, 2018). Implementing IoT systems fully in organizations without ensuring the absolute security of data might come at a cost too high for some companies and organizations to bear. Data breaches, a significant challenge to manage in most if not all organizations and companies, are usually caused by the lack of information security awareness. Stolen passwords are one of the most common causes of breaches. Hence, Sánchez Mallorquí, Briones, Zaballos, and Corral (2020) stress on the importance of including the awareness of IoT and cybersecurity in our education systems. If users are well educated on how to better protect them from being a victim of data breaches, such as social engineering, it will count as a step forward into a more protected network community. Additionally, with the increase in awareness toward security and privacy, organizations are implementing privacy enhancing technologies (PETs) to provide protection on consumers' data. PETS are closely related to the 'Privacy by Design' concept that embeds privacy protection measures directly in the infrastructure (Gan, Chua, & Wong, 2019).

5. Limitations and future research

The first limitation of this systematic review is the small number of literature found and the quality of such literature. When combining the search result numbers from databases used, the total value amounted to 2,501 search results. The literature was primarily filtered based on relevance to the subject matter and the associated themes highlighted in the discussion. Relevance is then determined through how IoT expressly impacts the satisfaction, well-being, health, productivity and/or security of an individual or group. Narrowing these down based on abstract then on full readthroughs, the total literature used amounted to 53 papers. The implication here is that while there was a broad assortment of literature to delve into, very little actually proved relevant to the objectives of this systematic review. Clearly, the issue is that not enough relevant literature has been produced to accurately quantify the impacts of IoT on happiness. While the literature presented in this systematic review shows that IoT can positively impact the perceived or explicit happiness of people, the amount of literature found to supplement this argument is still on the lower end.

A further extension to this limitation can be found in the literature relating to 'Education' in the discussion section. We currently understand education to be an important conversation to have when discussing the progression of IoT in education and how it can impact the performance and satisfaction of students and their educational aspirations. This specific parameter of the systematic review did not have an extensive amount of literature that could be integrated into the discussion. However, while not a lot of literature was found that acutely relayed information regarding how IoT is used or adapted in education, we felt it is important to retain education as a theme in this systematic review because there may yet be more important research that can be fulfilled to specifically account for IoT adoption in education and quantify the impacts of such a technological advent in people's educational experiences.

The second limitation lies in the lack of papers that can critically quantify the impacts of IoT within the respective themes established in this systematic review. A gap will likely be noticed in the expectations of IoT's impacts and the actuality of its impacts. Several papers discuss about the purported changes that IoT can bring in the future and to varying industries as well. However, the literature is specifically sparse when noting any quantifiable values with respect to how IoT can in fact impact the happiness of people.

The third limitation relates to the language of the literature found in this systematic review. IoT will certainly have overarching cultural and regional implications as it becomes a more pervasive element of contemporary life. In order to better understand this field in its totality, considering literature under different languages will become a necessity. While English might be the more prominent language among researchers in IoT, there may be merit to critically considering the literature based on different languages, specifically languages in China such as Mandarin and Cantonese. This limitation could serve to devalue the exploration of this paper as IoT can fundamentally impact different cultures and different regions. China is a thriving hub for the development of customer centric IoT devices. Chinese literature may resultantly provide a great degree of value if properly integrated.

Because of the aforementioned limitations, we can conclude a few significant takeaways in where future research needs to occur. First, the literature found in this systematic review can only serve to aid further research as IoT becomes a more regular fixture in society. Resultantly, research in IoT, with specific respect to its impacts on happiness, needs to occur at a more exponential rate. This can be achieved through a more rigorous assessment of IoT and how it impacts perceived happiness. The advents of happiness need to be specifically implied in future research in order to further supplement the existing literature. While a significant portion of literature can be found that relates in some fashion with IoT and happiness, a more stringent and focused approach to quantifying such impacts is required to argue these claims more coherently. Another important avenue to explore should be in how IoT is adapted in each of the identified themes: social, business, healthcare, education and workplace. For example, in the healthcare sector, future research can focus on more specific questions such as the impact of IoT application on happiness or the well-being in terms of the healthcare operations, physician, medicine or patient welfare. Focus can also be on the challenges and potential risks of applying IoT to healthcare including issues related to privacy and security. Another example is the education sector. More research is needed not only on the practical applications of IoT in classrooms and lectures but also in educating students of various backgrounds, cultures, ethics and regions of IoT on a broad basis. This may be achieved through educational institutions actively imposing academic material for courses and lectures that tackle the fundamental aspects of IoT as well as its sociotechnical impacts. Emphasizing this could go a long way to not only rectifying the gap in education but may further incentivize the development of the literature in the future.

Second, for this research to truly realize its furthest extents, additional work in the field needs to catalyze data that can be quantified and translated into observable impact. While quite a bit of the literature substantiates claims of the applications of IoT and what its effects could likely be, there is yet to be a resounding amount of literature that can actively quantify how IoT will impact varying industries and functions of society. This is likely due to the growing interest in IoT and the potential capabilities it has yet to reach. As we grow more familiar with IoT, we can expect literature that more specifically tackles its impacts to rise in number. The goal of this systematic review would then be in its provision of a platform with which this type of research can build on.

Third, language will always serve to be a barrier for the fullest formation of data, especially in this field. Language needs to be accounted for if future research is to be properly conducted. As stated earlier, while research done in IoT may mostly be found in the English language, this limitation takes away from the potential data that can be provided on IoT because we can be assured by its overarching impacts globally. Other research done on IoT should be formally translated for researchers around the world so that they may effectively make use of data that was not previously available for them. Should we attempt to understand how IoT impacts different cultures and regions, this would be necessary to amend gaps in knowledge.

Finally, as shown in Figure 3, security and privacy concern is the common factor in all the five themes identified in this study. The influence of IoT advancements has been the subject of numerous academic and social debates due to the security challenges and vulnerabilities posed by its rapid deployment (Gan *et al.*, 2019; Khan *et al.*, 2019). How public and private organizations store, track and use massive amounts of data produced by IoT devices is an area of major concerns for all IoT users. Future research should focus a lot more on issues related to security and privacy in order to see a wider adoption of IoT in society. While researchers have studied IoT for many years, much of this foregoing work has examined features, applications, challenges and vulnerabilities of IoT technologies (e.g. Dong, Ratliff, Cárdenas, Ohlsson, & Sastry, 2018; Shim *et al.*, 2019). Only a small number of studies examine the concept of happiness and IoT (e.g. Ahmad, Laplante, & DeFranco, 2020), and to the best of our knowledge, none investigate happiness returns from IoT systems. As such, future research should focus on aligning IoT and happiness into our lives in a more robust way. There should be a study that looks at whether people are happier when they are actively connected to one another and to everything around them. In addition, there should also be a study that looks at whether there is gain in societal happiness with the use of IoT. One way to achieve this is by going deeper into each of the themes identified in this study, for example, a study that focuses on the use of IoT in the workplace. The use of wearable devices at work that would tell when and where employees were most active and productive could easily intrude upon employee privacy but at the same time be deemed valuable to the company. This kind of study would be beneficial in understanding the impact of IoT and happiness or employees' well-being. Figure 4 shows a summary of suggested future research.

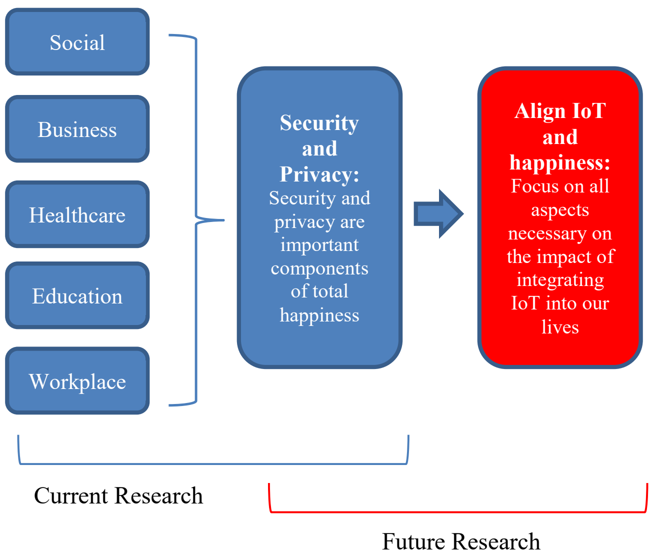

Figure 4.
Future research

6. Conclusion

This systematic review initially observed 2,501 literary articles through the ScienceDirect and WorldCat search engines before narrowing it down to 72 articles based on subject matter relevance in the abstract and keywords. Accounting for duplicates between search engines, the count was reduced to 66 articles. To finally narrow down all the literature used in this systematic review, 66 articles were given a critical readthrough. The count was finally reduced to 53 total articles used in this systematic review. Through reading the literature, commonalities were deduced from the papers used, and five themes were interpreted for the discussion. These were (1) social, (2) business, (3) education, (4) healthcare and (5) workplace. As a result, they represent the most important ventures for where IoT will go into in the years to come. This necessitates the claim that IoT will likely impact these sections of contemporary life and that research should be born through these avenues. Through the literature observed, the systematic review can confidently assess that IoT will have some significant and positive impacts on people's welfare and lives. The next steps to augmenting these claims will come in devising research that more stringently quantifies the impacts of IoT and happiness, as illustrated in Figure 4. Focus on research in this subject matter may likely lead to a better understanding of this technology and how we can best advance and adapt it to societal conventions. While the intention may be positive since the aim is to improve lives, the actual impact is still unclear. Will the use of IoT actually improve the happiness and social well-being of the users? Will it make people happier?

The general premise of this stems from an interest to provoke broader discourse on how IoT may benefit us in the future. The literature achieved through this exploratory process will often allude to experiences that pertain to happiness. However, the literature directly tackling the quantification of IoTs perceived influence on happiness has yet to be truly discussed broadly. The belief is that this systematic review may influence further intrigue in the subject matter. The unprecedented nature of IoTs' impacts on society should warrant further research moving forward. Advancing this research further matters because there is a trade-off between happiness and technology. It is therefore important for us to know if the published benefits of the IoT would indeed make people happier.

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Further reading

Watson, R. T., & Webster, J. (2020). Analysing the past to prepare for the future: writing a literature review a roadmap for release 2.0. *Journal of Decision Systems*, *29*(3), 129–147.

Appendix

Table A1. Complete list of papers reviewed

#	Paper Title	Author(s)	Journal	Year	Theme
1	A Big Data smart library recommender system for an educational institution	Aleksandar Simović	*Library Hi Tech*	2018	Education
2	A cognitive analytics management framework for the transformation of electronic government services from users' perspective to create sustainable shared values	Ibrahim H.Osman, Abdel Latef Anouze, Zahir Irani, Habin Lee and Tunc D. Medeni	*European Journal of Operational Research*	2019	Workplace
3	A conciliation mechanism for self-organizing dynamic small groups	Minglun Ren, Zhongfeng Hu and Hemant Jain	*SpringerPlus*	2016	Workplace
4	A smart healthcare reward model for resource allocation in smart city	Soraia Oueida, Moayad Aloqaily and Sorin Ionescu	*Multimedia Tools and Applications*	2019	Healthcare
5	A socio-technical framework for Internet-of-Things design: A human-centered design for the Internet of Things	Donghee Shin	*Telematics and Informatics*	2014	Social
6	A Trusted Ubiquitous Healthcare Monitoring System for Hospital Environment	Durga Prasad, Niranjan N Chiplunkar and K Prabhakar Nayak	*International Journal of Mobile Computing and Multimedia Communications*	2017	Healthcare
7	Achieving Service Process Excellence With Connected Customer: A Winning Approach	Samir Yerpude, Tarun Kumar Singhal and Hiren Rajeshkumar Rathod	*International Journal of Information Systems and Supply Chain Management*	2019	Business
8	An information provision system to promote energy conservation and maintain indoor comfort in smart homes using sensed data by IoT sensors	Kanae Matsui	*Future Generation Computers Systems*	2018	Social
9	An Integral Pedagogical Strategy for Teaching and Learning IoT Cybersecurity	Julia Sánchez, Adrià Mallorquí, Alan Briones, Agustín Zaballos and Guiomar Corral	*Sensors*	2020	Workplace
10	An intelligent logistics service system for enhancing dispatching operations in an IoT environment	Jianxin Wang, Ming K Lim, Yuanzhu Zhan and XiaoFeng Wang	*Transportation Research Part E: Logistics and Transportation Review*	2020	Business
11	An Intelligent-Internet of Things (IoT) Outbound Logistics Knowledge Management System for Handling Temperature Sensitive Products	Joseph SM Yuen, KL SM Choy, HY SM Lam and YP SM Tsang	*International Journal of Knowledge and Systems Science*	2018	Business
12	An Internet of Things (IoT)- based risk monitoring system for managing cold supply chain risks	Y P Tsang, K L Choy, CH Wu, GTS Ho, Cathy HY Lam and P SKoo	*Industrial Management and Data Systems*	2018	Business

(*continued*)

Table A1.

#	Paper Title	Author(s)	Journal	Year	Theme
13	An IoT Guided Healthcare Monitoring System for Managing Real-Time Notifications by Fog Computing Services	Neel Mani, Akhil Singhb and Shastri L Nimmagadda	*International Conference on Computational Intelligence and Data Science (ICCIDS 2019)*	2020	Healthcare
14	An Optimal Energy-Saving Strategy for Home Energy Management Systems with Bounded Customer Rationality	Guoying Lin, Yuyao Yang, Feng Pan, Sijian Zhang, Fen Wang and Shuai Fan	*Future Internet*	2019	Social
15	Application of smart wearable sensors in office buildings for modelling of occupants' metabolic responses	Sandro Nizetic, Nikolina Pivac, Vlasta Zanki and Agis M. Papadopoulos	*Energy and Buildings*	2020	Workplace
16	CE-GMS: A cloud IoT- enabled grocery management system	Jasleen Kaur and Pankaj Deep Kaur	*Electronic Commerce Research and Applications*	2018	Business
17	CONSIGNELA: A multidisciplinary patient-centered project to improve drug prescription comprehension and execution in elderly people and parkinsonian patients	Gregory Moro Puppi, Wanderleya, Élodie Vandenbergh, Marie-Hélène Abel, Jean-Paul A. Barthès, Mathieu Hainselin, Harold Mouras, Aurélie Lenglet and Mélissa Tird,f, Laurent Heurley	*Telematics and Informatics*	2018	Healthcare
18	Crowdsensing for a sustainable comfort and for energy saving	D. Cottafava, S. Magariello, R. Ariano, O. Arrobbio, M. Baricco, V.M. Barthelmes, G. Baruzzo, M. Bonansone, L. Console, L. Contin, S.P. Corgnati, S. Dotta, V. Fabi, P. Gambino, I. Gerlero, A. Giovannoli, P. Grillo, G. Guaschino, P. Landolfo, M. Malano, D. Mana, A. Matassa, L. Monterzino, S. Mosca, M. Nuciari, E. Olivetta, D. Padovan, E. Pantó, A. Rapp, M. Sanseverino, A. Sciullo, S. Sella, R. Simeoni, A. Tartaglino and F. Vernero	*Energy and Buildings*	2019	Social
19	Data and Privacy: Getting Consumers to Trust Products Enabled by the Internet of Things	Khan, W. Z., Aalsalem, M. Y., Khan, M. K. and Arshad, Q	*IEEE Consumer Electronics Magazine*	2019	Social
20	Designing privacy-aware internet of things applications	Charith Perera, Mahmoud Barhamgi, Arosha K. Bandara, Muhammad Ajmal, Blaine Price and Bashar Nuseibeh	*Information Sciences*	2020	Social
21	Digital Health in the Era of Extreme Automation	Jinan Fiaidhi and Sabah Mohammed	*IT Professional*	2018	Healthcare

(*continued*)

Table A1.

#	Paper Title	Author(s)	Journal	Year	Theme
22	Efficient service recommendation using ensemble learning in the internet of things (IoT)	Javad Pashaei Barbin, Saleh Yousefi and Behrooz Masoumi	*Journal of Ambient Intelligence and Humanized Computing*	2019	Social
23	ElHealth: Using Internet of Things and data prediction for elastic management of human resources in smart hospitals	Gabriel Souto Fischer, Rodrigo da Rosa Righi, Gabriel de Oliveira Ramos, Cristiano André da Costa and Joel J.P.C. Rodrigues	*Engineering Applications of Artificial Intelligence*	2020	Healthcare
24	Emotions detection on an ambient intelligent system using wearable devices	Angelo Costa, Jaime A. Rincon, Carlos Carrascosa, Vicente Julian and Paulo Novais	*Future Generation Computer Systems*	2019	Social
25	Evaluating Internet of Medical Things (IoMT)-Based Systems from a Human-Centric Perspective	Christos Kotronis, Ioannis Routis, Elena Politi, Mara Nikolaidou, George Dimitrakopoulos, Dimosthenis Anagnostopoulos, Abbes Amira, Faycal Bensaali and Hamza Djelouat	*Internet of Things*	2019	Healthcare
26	Exploiting IoT technologies for enhancing Health Smart Homes through patient identification and emotion recognition	Leandro Y. Mano, Bruno S. Faiçal, Luis H.V. Nakamura, Pedro H. Gomes, Giampaolo L. Libralon, Rodolfo I. Meneguete, Geraldo P.R. Filho, Gabriel T. Giancristofaro, Gustavo Pessin, Bhaskar Krishnamachari and Jó Ueyama	*Computer Communications*	2016	Social
27	Healthcare service evolution towards the Internet of Things: An end-user perspective	Eva Martínez-Caro, Juan Gabriel Cegarra-Navarro, Alexeis García-Pérez and Monica Fait	*Technological Forecasting and Social Change*	2018	Healthcare
28	How IoT Has Been Changing The Face Of Business	Saarthak Bakshi	*Businessworld*	2018	Healthcare
29	How IoT is inviting insurers into smart homes	Joel Makhluf	*Trade Journals*	2017	Social
30	IAMHAPPY: Towards an IoT knowledge-based cross- domain well-being recommendation system for everyday happiness	Amelie Gyrard and Amit Sheth	*Smart Health*	2020	Social
31	Improving a production site from a social point of view: an IoT infrastructure to monitor workers condition	Fabio Gregori, Alessandra Papetti, Monica Pandolfi, Margeherita Peruzzini and Michele Germani	*51st CIRP Conference on Manufacturing Systems*	2018	Workplace
32	Improving business process and functionality using IoT based E3-value business model	Alaa Shoukry, Jameel Khader and Showkat Gani	*Electronic Markets*	2019	Business

(*continued*)

Table A1.

#	Paper Title	Author(s)	Journal	Year	Theme
33	Internet of things (IoT) applications to fight against COVID-19 pandemic	Singh RP, Javaid M, Haleem A and Suman R	*Diabetes and Metabolic Syndrome: Clinical Research and Reviews*	2020	Healthcare
34	Internet of Things (IoT) in Tourism and Hospitality: Opportunities and Challenges	Tomislav Car, Ljubica Pilepić Stifanich and Mislav Šimunić	*Conference: Tourism in Southern and Eastern Europe: Creating Innovative Tourism Experiences: The Way to Extend the Tourist Season*	2019	Business
35	Internet of Things and Libraries: An Empirical Study of Selected Educational Institutions in United Arab Emirates	Elangovan Alagumalai and Radhakrishnan Natarajan	*Library Philosophy and Practice*	2020	Education
36	Internet of Things in the Workplace	Franklin Ramsoomair and Elliot Kolb	*I-Manager*	2018	Workplace
37	IoT + AR: pervasive and augmented environments for “Digi-log” shopping experience	Dongsik Jo and Gerard Jounghyun Kim	*Human-centric Computing and Information Sciences*	2019	Business
38	IoTFLiP: IoT-based flipped learning platform for medical education	Maqbool Ali, Hafiz Syed Muhammad Bilala, Muhammad Asif Razzaqa, Jawad Khana, Sungyoung Leea, Muhammad Idrisb, Mohammad Aazamc, Taebong Choid, Soyeon Caren Hane and Byeong Ho Kange	*Digital Communications and Networks*	2017	Education
39	Patient satisfaction in emergency department: Unveiling complex interactions by wearable sensors	Alessandro Stefaninia, Davide Aloinia, Peter Gloorb and Federica Pochieroa	*Journal of Business Research*	2019	Healthcare
40	Patient Satisfaction with Mobile Health (mHealth) Application for Exercise Intervention in Breast Cancer Survivors	Hannah Lee, Kyeong Eun Uhm, In Yae Cheong, Ji Sung Yoo, Seung Hyun Chung, Yong Hyun Park, Ji Youl Lee and Ji Hye Hwang	*Journal of Medical Systems*	2018	Healthcare
41	Privacy Enhancing Technologies implementation: An investigation of its impact on work processes and employee perception	May Fen Gan, Hui Na Chua and Siew Fan Wong	*Telematics and Informatics*	2019	Workplace
42	Product delivery service provider selection and customer satisfaction in the era of internet of things: A Chinese e-retailers’ perspective	Jie Yu, Nachiappan Subramanian, Kun Ning and David Edwards	*International Journal of Production Economics*	2015	Business
43	Profiting From IoT: The Key Is Very-Large-Scale Happiness Integration	Kazuo Yano, Tomoaki Akitomi, Koji Ara, Junichiro Watanabe, Satomi Tsuji, Nobuo Sato, Miki Hayakawa and Norihiko Moriwaki	*2015 Symposium on VLSI Circuits Digest of Technical Papers*	2015	Social

(*continued*)

#	Paper Title	Author(s)	Journal	Year	Theme
44	Residential Consumer-Centric Demand-Side Management Based on Energy Disaggregation- Piloting Constrained Swarm Intelligence: Towards Edge Computing	Lin Yu-Hsiu and Hu Yu-Chen	*Sensors*	2018	Social
45	Revealing household characteristics using connected home products	Sungil Kim	*Information Sciences*	2019	Social
46	Security, privacy and trust in Internet of Things: The road ahead	S Sicari, A Rizzardi, LA Grieco and A Coen-Porisini	*Computer Networks*	2015	Social
47	System for recognizing lecture quality based on analysis of physical parameters	Ana Uzelac, Nenad Gligoric' and Srdan Krčo	*Telematics and Informatics*	2018	Education
48	The Development and Application of a STEAM Program for Middle School Students Using an Internet of Things Teaching Aid	Jinmi Tae	*International Journal of Computer Science and Information Technology for Education*	2017	Education
49	The Effect of "Internet of Things" on Aircraft Spare Parts Inventory Management	S. Keivanpour and D. Ait Kadi	*IFAC PapersOnLine*	2019	Business
50	The impact of Internet of things implementation on firm performance	Chia-Pei Tang, Tony Cheng-Kui Huangb and Szu-Ting Wang	*Telematics and Informatics*	2018	Workplace
51	The Internet of Beings: Using Big Data for optimizing corporate policies	Kiran Kumar	*Trade Journals*	2016	Workplace
52	The Internet of Things (IoT) in retail: Bridging supply and demand	Felipe Caro and Ramin Sadr	*Business Horizons*	2019	Business
53	Using the IoT to Increase Productivity	Robert Martens	*Security Technology Executive*	2017	Workplace

Table A1.

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Norita Ahmad is a professor of management information system (MIS) at the American University of Sharjah. She received her PhD in decision science engineering systems from Rensselaer Polytechnic Institute in 2005. She has an MSc in telecommunications and network management from Syracuse University and BSc. in computer science from Syracuse University. Her research interest includes innovative uses of information technology, decision analysis and technology adoption. She published in a variety of scholarly journals such as *IT and People*, *IS Frontiers*, and *Journal of Knowledge Management*. She is a member of Institute of Electrical and Electronics Engineers (IEEE). Norita Ahmad is the corresponding author and can be contacted at: nahmad@aus.edu

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