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Demand Response Readiness in Retail Stores

DR Control Preferences, Stakeholder Engagement, and Cross-National Differences

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***Abstract*—**Retail buildings can provide energy flexibility to the grid with the possibility of load shifting and building automation systems. Demand response is a collective innovation in the smart grid domain. Various stakeholders should be involved in the demand response activities to ensure the success. The owners or senior management of retail buildings need to consider the stakeholders who are directly influenced by the demand response participation, e.g. customers and employees. Meanwhile, demand response activities are influenced by various factors, such as energy market structure, policy, etc. Therefore, this paper investigates the demand response readiness for retail buildings with three aspects: energy control preferences, stakeholder engagement, and cross-national differences. A questionnaire is designed and collected with store managers in Denmark (N=51) and the Philippines (N=36). The result shows that: 1) retail stores are much readier to participate in the implicit demand response by manual energy control compared to the utility control or building automation. Meanwhile, store managers have significant concerns about business activities and indoor lighting compared to other aspects; 2) the statistically significant influential factors for retail stores to participate in the demand response are related to whether the DR participation matches the company goals, influences business operation, and whether retail stores are lack of related knowledge; 3) retail stores believe that stakeholders should be informed about the DR activities but not involved in; 4) there are significant differences regarding the energy control preferences and concerns between retail stores in Denmark and the Philippines, but no significant difference regarding the stakeholder engagement.

Keywords*—energy flexibility; retail stores; influential factors; employee engagement; customer engagement; utility collaboration*

I. INTRODUCTION

The smart grid is one of the most effective and economic solutions on the path to a future energy system [1]. The smart grid functionality depends on the collaboration and integration of different stakeholders, adoption of new technologies, regulations and business models [2-5]. The existing literature indicates the importance of consumer engagement in the demand response (DR) management that can contribute to the stability and agility of the smart grid [6, 7].

The energy flexibility provided by consumers depends on the types of consumers, e.g. industrial, commercial and residential consumers [2]. For instance, refrigeration companies/ cold stores have especially high load shift potential with the duration of several hours, and there are several ways to make electricity from the refrigerators/ freezers more flexible [8]. However, the majority of the industrial processes are more resistant to provide energy flexibility compared to the commercial activities due to the continuous production. DR in commercial buildings is popularly discussed due to 1) about one-third of the overall commercial buildings are equipped with building automation systems (BAS) in many developed countries, 2) BAS already integrates the HVAC (Heating, ventilation, and air conditioning) control systems that can manipulate the control variables needed for providing regulation services, 3) a large fraction of commercial buildings are

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equipped with fast-responding variable frequency drives (VFDs) [9]. However, some commercial buildings are more reluctant to participate in DR due to the influences on their business routines and profits [10]. For instance, hotels and hospitals operate 24/7 and are in general reluctant to shift their usage of power due to consideration of their profits or occupants' comfort.

Therefore, the success of demand response is related to various aspects, e.g. regulation, consumers' motivation, electricity suppliers' support, and also depends on the collaboration of all the smart grid actors [11]. The flexibility activation can require the establishment of the agreements between different actors. Following agreements may be negotiated between aggregators and prosumers, such as: security of supply on time from prosumers' side, comfort requirements from prosumers' side, framework for billing, and aggregator's active marketing role to engage consumers in the delivery of flexibility products (to DSOs (Distribution System Operators)/ grid companies, TSOs (Transmission System Operators) etc.) [12]. However, although the importance of consumer engagement is well discussed (e.g. [6, 13]), few studies have investigated it from the perspective of stakeholders and stakeholders' interaction. Particularly, the cross-national aspect is missing in the literature, although the energy market structure and social culture strongly influence electricity consumers' behaviors.

This paper presents the results of a survey study conducted in Denmark and the Philippines to investigate the demand response readiness of commercial buildings with three aspects: DR control preferences, customer engagement, and cross-national differences. Retail stores are selected as the surveyed respondents because there are various energy flexibility resources (e.g. freezers, lighting, etc) and stakeholders involved in the retail stores.

Retail store is one type of commercial buildings selling a variety of products, owned or operated by the retailers [14]. Retail stores are large commercial energy consumers, as they have round-the-clock business operations [15]. The energy consumption of retail stores depends on the nature of the business, store format, products, shopping activities of customers and store equipment [16]. There are many ways to do energy control for retail stores. For instance, improving lighting system design and incorporate daylight-saving reduces energy costs in a building [17]. Retail stores can potentially provide various energy flexibilities, such as the flexible operation of refrigeration in the supermarkets. Meanwhile, there are many stakeholders involved, including store managers, employees, and the consumers of the consumers: buyers.

Two countries are selected in the paper: Denmark and the Philippines for a comparative study to fill the literature gap in the across-national energy flexibility. The literature on the cross-national comparison in energy flexibility mainly focus on the energy consumption (e.g. [18]), renewable energy resources (e.g. [19]) and building energy use and regulations (e.g. [20]). There is no cross-national study on the energy flexibility of retail stores. There are many differences between Denmark and the Philippines, e.g. climate, regulation, economics, and culture. These differences can help us to further understand the similarities and differences between countries.

This paper firstly discusses the related literature on energy flexibility in retail stores, and then introduces the adopted methodology. The section of results and discussion presents the results of the surveyed data analysis include three parts regarding preferences and concerns for DR control options, influential factors for DR program participation, and internal and external stakeholders' DR activity participation. Finally, a rational and object-oriented approach for retail stores preparing the energy flexibility readiness is proposed and discussed.

II. RESEARCH BACKGROUND

Energy management activities in retail stores vary according to store conditions, e.g. store size, store type [15]. Other factors, such as energy plans, responsible staffs, existing/new buildings and store activities, also affect the energy adoption in retail stores. Meanwhile, energy price, consumption, climate, and infrastructures vary according to regions or locations. Beside store conditions, DR control options, store managers' preferences and concerns, and stakeholders' involvement influence the success of DR implementation in retail stores:

1. Demand response control options and retail stores' concerns

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There are two types of demand response (DR) programs: explicit and implicit demand response. The two types of DR programs are activated at different times and serve different purposes in markets [21]. Implicit DR (sometimes called price-based DR) assumes that electricity consumers may alter their electricity consumption due to a price signal that is provided at a different time [22]. Meanwhile, explicit DR (also called incentive-based DR program) is divided into traditional-based (e.g. direct load control, interruptible pricing) and market-based (e.g. emergency demand response programs, capacity market programs, demand bidding programs, and ancillary services market programs) [23]. In explicit DR, load requirements (size of energy consumption) need to comply to participate in DR programs [24].

However, the acceptance and adoption of the DR options not only depend on the monetary benefits of DR programs but also the energy use and consumers' behaviors. The retail stores' energy consumption focus on various areas including indoor and outdoor lightings, heating, air-conditioning, building maintenance, planning/ operations, refrigeration and lobbying [25]. The indoor air quality (IAQ) is one of the important components in the energy management for the retail stores due to the building regulation and customers' satisfaction [26]. Meanwhile, the energy plan and activities in the retail stores need to consider the retail store image, cost, competition, regulations, internal concerns, and customer satisfaction. The retail store image is an essential element as it influences customers' shopping decisions.

The DR activities in the retail stores are influenced by the availability and readiness of the energy flexibility technologies. The technologies provide the resources of the energy flexibility in the retail stores. Lightings, refrigerators, and ventilation are common technologies available in stores. Lighting is the most important technology considered in buildings. Effective lighting can increase shoppers' satisfaction and encourage them to spend more time in the stores [27]. Meanwhile, Store lighting is a high energy expenditure in the retail stores. There is a need for lighting for refrigerators, walk-in coolers, sales areas, and garage/parking. The energy consumption can be reduced by as much as 50% with the simple application of energy efficiency technologies [28]. Refrigeration is used to store perishable products in the stores sharing up to 47% of energy consumption in retail store [29]. There are several technologies that can improve the energy efficiency of the refrigeration in supermarkets, such as anti-sweat heater controls for refrigerated cases, strip curtains for walk-in coolers and freezers to help mitigate cold air spill. Ventilation provides comfort to building occupants (e.g. staffs and customers) and increase stores' productivity [26]. Ventilation rates are mandated by regulations and standards, such as indoor air quality, health requirements, and climate. The ventilation control technologies and strategies (e.g. HVAC control systems) not only can provide the energy saving but also the energy flexibility [30, 31].

2. Influential factors in the demand response acceptance by retail stores

Majority of retail stores have been aware of the importance of the energy saving and energy efficiency. Literature indicates that the influential factors that might impact retail stores' acceptance of demand response can be divided into financial technological, business, legal and environmental aspects.

The demand response enhances the energy efficiency of the retail stores, utilities, and grid operators. Recent research shows that demand response is considered as a secondary revenue stream for a supermarket chain as it lowers electricity cost [29] and lowers the wholesale energy market prices [32]. For instance, the demand response in the refrigeration system allows the adjustment of the demand for electricity [29]. Moreover, the energy crisis is a driver for the demand response implementation in retail stores. Recent research shows that that retail stores agree that there is an energy crisis in the US and it has affected their store operation [25]. The increasing energy cost affects the product pricing in grocery stores and food supermarkets [25, 33]. Although the electricity cost is only 1% of the total supermarket operating cost, retail stores are interested in any financial incentive that can generate profits [29]. It especially drives the stores that consume a large amount of electricity (e.g. grocery, food supermarket) to consider the energy flexibility.

Retail stores comply with the political directives when it is implemented through the retail organizations or association [25]. Retailers adopt energy efficient technologies and flexibility resources (e.g. PVs or energy storage) mainly due to the energy legislation and building regulations. For instance, the food supermarkets apply the efficient energy technologies because of the rising energy cost and campaigns of Non-Governmental

Organization (NGO) to reduce Greenhouse gas (GHG) emissions [33]. However, not all supermarkets are convinced to adopt demand response programs [33]. Tassou et al. [34] research shows that retail stores receive pressure to practice energy management because of the energy legislation implemented by the government. The policymakers need to increase their effort in reaching out to the retail industries by building a strong communication channel and utilizing the energy information [25]. For instance, in the US, the Department of Energy (DOE) provides a web-portal as an information tool to build a strong collaboration with their energy partners (e.g. retail stores) [30].

Retail stores are a highly competitive customer-driven market, and the first priority of retail stores is developing effective strategies to attract different types of customers (e.g. new or existing customers, and green-conscious consumers) [33]. Research shows that customers' behaviors and shopping decisions can be influenced by the retail stores' reputation and strategies. The business strategies include factors of demands, beliefs and customer values. Corporate Social Responsibility (CSR) is an effective strategy to create a sustainable competitive advantage and develop a good company image, trust with the local communities and customers [33]. A good CSR strategy can catch customers' attention, e.g. creating customers' awareness on the utilization of efficient energy technologies in retail stores and the benefits of environmental-friendly and health-related smart energy. Another example of good CSR practice is providing an environmental friendly condition to the users without a high amount of energy [16]. In general, good CSR practices are common strategies for the energy flexibility in the retail stores with the collaboration between retailers and customers/local communities.

3. Stakeholders' involvement in the retail stores' demand response activities

There are internal and external stakeholders potentially involved in the demand response for retail stores, and they participate in different roles. The literature identifies that the main internal stakeholders in the stores are building/store owners and managers, energy managers, and shop-floor staffs.

Building owners are the owners of buildings. They collaborate with the design teams for the designing of the energy efficient and flexible buildings with related technologies. Usually, the building owners are responsible for implementing the energy development program in retail stores [15]. Building/store managers collaborate with governments and other stakeholders regarding the monetary energy efficiency incentive programs [30]. They are responsible for supervising the buildings' security, maintenance and repair in accordance with buildings' environmental and safety standards. On the other hand, store managers [33] are responsible for energy management practices in retail stores and manage the retail store operation [15]. Energy management specialists or retail energy managers are assigned in the corporate department of large retail stores with the responsibility of developing effective energy management plans, evaluation and installation of energy management technologies, and negotiating with the utility partners regarding the electricity prices [1].

Shop-floor-staffs work under the supervision of the store managers. They are responsible for the maintenance of the stores' daily operation including the energy management practice in the stores [15]. There might be multiple-goal conflicts affect shop-floor staffs' involvement in the demand response activities in stores [35]. Some of the demand response activities affect shop-floor staffs rather than customers. For instance, the customers might not be aware the indoor temperature changes in the supermarkets, but the temperature changes would significantly influence the shop-floor staffs due to the long working duration in the supermarkets. A survey shows that shop-floor staffs do not actively participate in the energy efficiency programs of the retail stores unless the energy-related programs are considered as a part of the job functions or with incentives (e.g. credit, or bonus) [35].

Several external stakeholders might influence retail stores' energy management strategies. For instance, utility companies supply energy to retail stores, and concern profit from generating and saving energy [36]. The partnership between the retailers and utility companies brings energy flexibility products/solutions closer to the retailers. For example, in the US, utility companies and retailers work together and create the "build your own energy" incentive solution to respond to the government's energy development program. This energy incentive program serves as a tool to utilize efficient energy technologies for new construction and existing retail store buildings [30]. However, in general, there is still lack of incentive of energy flexibility participation

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from the utilities or governments, either some utility incentives are not applicable to retail stores, nor some incentives are classified on certain groups (e.g. motor replacement or one-for-one equipment change out incentives) [30].

Local communities refer to a group of people or individuals in the society and involve in different community programs (e.g. incentive energy efficiency program) [30]. Retail store customers are involved in shopping and buying activities in the retail stores. The "energy retail stores customers" are classified as environmentally conscious, cost-conscious and technology-conscious customers [36]. Literature shows that the demand response activities in retail stores do not significantly influence customers' shopping experience. An experiment in a large British supermarket shows that the customers do not realize the changes in the indoor temperature during the experiment. Meanwhile, the energy control systems provide the energy flexibility potentials with customers' interaction [33].

The literature shows that some external stakeholders indirectly influence the energy performance and plan in retail stores. For instance, third-party private operators collaborate with the retailers in the renovation of building design, energy development, and energy production. Third-party private operators consist of remodeling specialists, energy development consultants, energy engineers and energy researchers. Remodeling specialists [5] involve in the building renovation or redesign. The development consultants are independent contractors who are hired by an organization to develop effective energy management plans. On the other hand, energy engineers [36] involve in the energy production and are also involved in energy equipment design and selection. Meanwhile, governments or regulators are involved in planning and developing energy policies [2], regulate energy rules that shape the future energy systems (e.g. Department of Energy) [30].

4. Cultural impact on the building energy flexibility

The smart grid becomes a priority of many countries due to various national reasons like growing population size or climate change. The reasons and solutions for the energy flexibility across countries vary due to the maturity of the energy system and the renewable energy resources potentials. Other factors might also influence the national energy flexibility development, such as economic and climate situations.

Taking Denmark and Philippines as an example, both countries have high electricity price. Denmark has the highest electricity price in Europe [37], and there is little motivation for buildings in Denmark to provide energy flexibility due to the high percentage of tax and grid tariffs in the electricity price [38]. The Philippines has one of the most expensive electricity prices in Asia [39] because the country is dependent on imported fuel and the government does not provide electricity subsidy. In the Philippines, private distribution utilities decide the electricity retail price according to locations and types of consumers. Comparatively, there is an unbundling electricity market in Denmark.

Furthermore, the resources of energy flexibility provided by buildings in Denmark and the Philippines are different. For instance, the majority of residential buildings are not equipped with the air conditioning in Denmark but district heating. Comparatively, the air conditioning is compulsory in buildings (if the building owners can afford) due to the climate, but no heating system in the Philippines. In the Philippines, the solar panels are commonly installed in buildings. However, the electricity produced from the solar panels is only for self-usage and is not allowed to sell back to the grid. In Denmark, buildings with solar panels are allowed to sell the electricity produced from the solar panels to sell back to the grid. Therefore, the incentives for buildings to provide energy flexibly between Denmark and the Philippines are different.

Meanwhile, buildings in the Philippines have to provide energy flexibility by tolerancing frequent electricity blackout. With a population of more than 100 million people, there are 16 million who are not connected to the electricity grid in the Philippines [40]. Comparatively, there would be only 7 minutes of power shortage in Eastern Denmark, in 2018 [41].

III. METHODOLOGY

To investigate the demand response readiness of retail stores with the aspects of DR control preferences, customer engagement, and cross-national differences, this paper was targeted to survey altogether 200 managers of retail stores, 100 in Denmark and 100 Philippines. The questionnaire includes four parts based on

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the literature review and expert input as shown in Table 1. To ensure content validity, the measures used in this study were adapted from established scales used in previous studies. For instance, a 5-point Likert scale was used for the part of motivation, barriers, and concerns, and the measures for this part were adapted from the studies by [42] on the application of households' energy flexibility. With regard to the selection of the control strategies and stakeholders surveyed, this paper was guided by the literature on energy flexibility in retail stores and commercial buildings (e.g. [24] [36]).

The data collection in Denmark was conducted in April 2017, and the Philippines in December 2016. Of these, 113 refused to participate due to the lack of interest or knowledge, resulting in a sample with a 43.5% response rate. Among the 87 surveyed managers, 51 were from Denmark and 36 from the Philippines. The surveyed managers were either store managers or energy managers that were in charge of energy management in their stores.

All surveys were conducted by face to face visits describing the survey and explanation of survey questions. It reduced the barriers for participants to answer the questions regarding the concept of a smart grid, energy flexibility and control options that might not be familiar to some store managers.

The official languages of the Philippines are English and Filipino. The questionnaire is designed in English for the Philippines, and the data collection was conducted by a native Filipino, and she spoke either English or Filipino based on the managers' familiar languages locally. The questionnaire was translated into Danish for the data collection in Denmark and the data collection was conducted by native Danish researchers. The questionnaire was designed and conducted by eight researchers with different knowledge levels of the energy flexibility in buildings. Each questionnaire was collected by computer-assisted face-to-face interviewing that researchers explained each question and filled the answers with surveyed respondents.

The descriptive analysis is performed to uncover retail stores' preferences and concerns about DR control options, DR activities, and stakeholders' involvement. The data analysis is conducted with the statistical analysis software SPSS to analyze the cross-national differences and similarities, and retail stores' concerns towards DR options. The surveyed results are presented and discussed in section IV.

Table 1. questionnaire content

Questionnaire section	Contents
Background	• Number of employees • Number of stores • Store type
Control Strategies	• Preferences for control options • Concerns regarding control options
Motivation, barriers and concerns	• Financial aspects • Technological aspects • Business aspects • Legal and environmental aspects
Stakeholders' involvement	• Employees and floor staffs • Customers • Utility companies

IV. RESULTS AND DISCUSSION

1. Preferences and concerns for DR control options

From the store managers' point of view, there are three energy control options for providing the energy flexibility to the grid:

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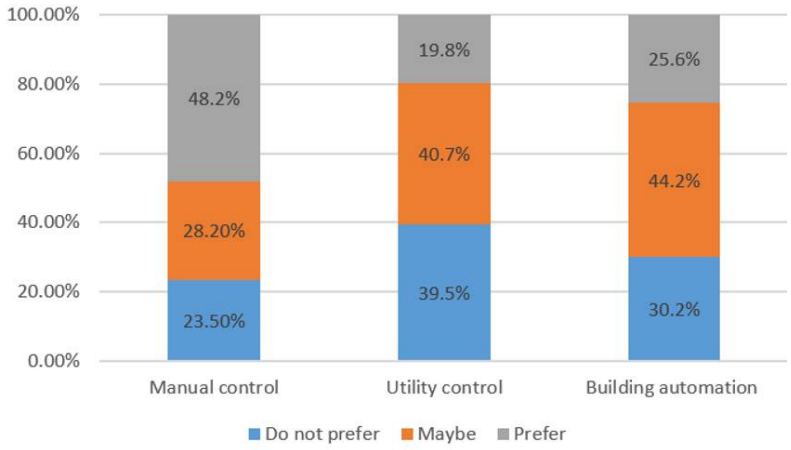
- Manual control - buildings manually turn on/off equipment and change set points in reaction to high electricity prices
- Utility control- allow utility companies to send signals that would control electricity powered appliance in buildings
- Building automation - Introduce an automatic system in buildings that can respond automatically to high prices

In Figure 1, the survey result shows that 48.2% of store managers were willing to do manual control to react to the electricity prices, whereas only 19.8% and 25.6% were willing for utility control and building automation, respectively Manual control was mainly applied in the current DR program. The result corresponds to the current situation that store managers are more willing to participate in the implicate DR (e.g. peak/off-peak hours) compared to explicit DR (e.g. real-time pricing) [21]. There is large discussion regarding aggregators and their business models. The result shows that 39.5% of store managers are not willing to accept utility control compared to 30.2% unwillingness of building automation. Therefore, aggregators might consider control building energy via buildings' own automation with price signals.

A Mann-Whitney U test indicated a statistically significant difference in the preference of manual control between Denmark (mean 34.5) and Philippines (mean 55.6). The result shows that the surveyed store managers in Denmark preferred manual control significantly more often than those in the Philippines ($U = 433{,}5$, $p < .001$). meanwhile, no statistically significant difference in preferences with utility controls or building automation between these two countries was observed.



Question: Which control options would you prefer if your store should more actively control its electricity consumption

Figure 1. The percentage of surveyed managers' preferences regarding the control options

Regarding the store managers' concerns for DR control options, the survey result (Figure 2) shows that the top four concerns for store managers are: 'indoor lighting', 'causing damages to equipment', 'interfering with business activities', and 'effective energy bill saving'. The result shows that the main concerns for store managers are maintaining the normal building operations and financial benefits.

Figure 3 shows that the top 3 concerns for the Danish store managers are: 'interfering with business activities', 'indoor light and compromising customers/occupants' experience'. Compared to the Danish store managers, the store managers in the Philippines concern more about 'causing damages to equipment', 'effective energy bill saving', 'indoor lighting' and 'interfering with business activities'. Surprisingly, store managers in both Denmark and the Philippines do not concern so much about 'privacy' or 'user-friendly control'.

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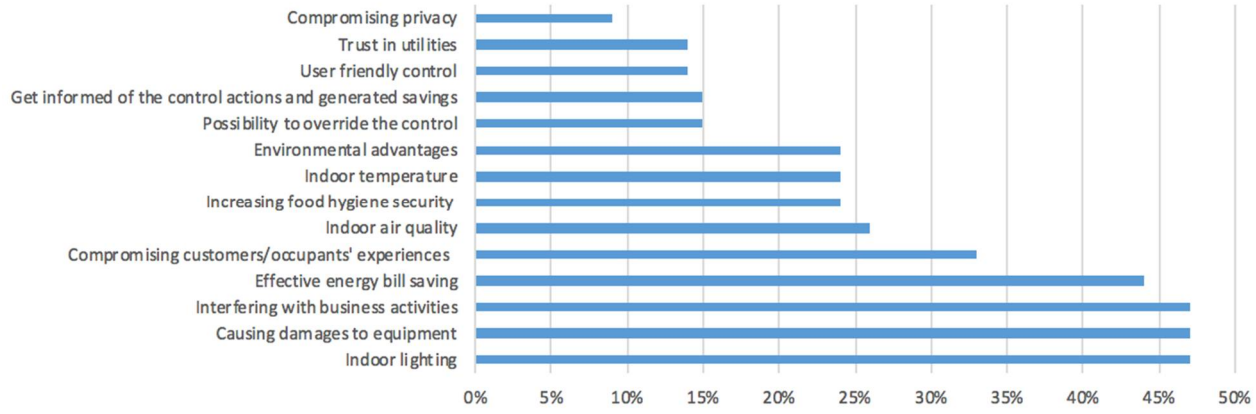

Figure 2 The percentage of surveyed managers' concerns regarding DR control options. N = 87

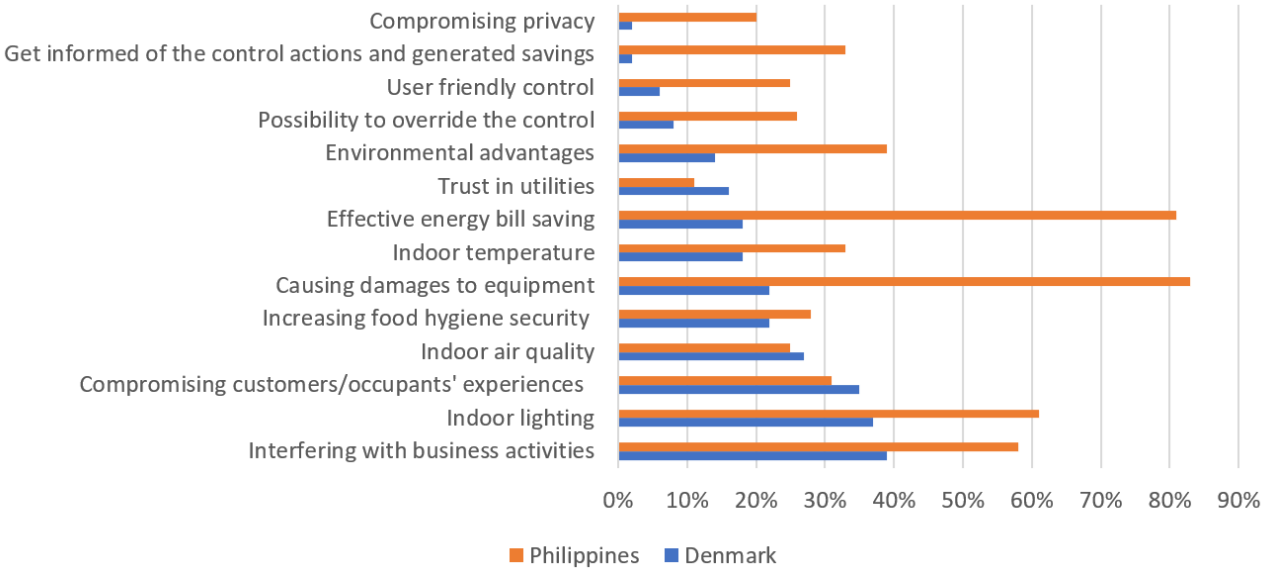

Figure 3. Comparison of the percentage of respondents reporting on being considered of given DR control options per surveyed country. N = 51 (Denmark), N = 36 (Philippines)

A Chi-Square test shows that there are four concerns that influence surveyed managers' options on the DR manual control: equipment damage ($\chi^2(2) = 14.175$, $p < 0.001$), energy bill ($\chi^2(2) = 10.29$, $p < 0.01$), indoor lighting ($\chi^2(2) = 8.033$, $p < 0.05$) and indoor temperature ($\chi^2(2) = 7.391$, $p < 0.05$). The result shows that only indoor lighting ($\chi^2(2) = 10.181$, $p < 0.01$) influences the DR utility control options. Meanwhile, the 'possibility to override the control' ($\chi^2(2) = 7.4$, $p < 0.05$) has a significant influence on the option of building automation.

2. Influential factors for retail stores to participate DR programs (motivation, barriers and concerns)

The factors that potentially influence store managers to participate in DR programs can be divided into financial, technological, business, legal and environment aspects. Figure 4 shows the ranking of the influential factors that store managers consider to be important for the participation of DR programs. Among the influential factors, store managers concern more about the business aspects, legal and environmental aspects are the least important compared to other aspects (summarized in Table 2).

Store managers in Denmark are more concerned about the surveyed factors compared to those in the Philippines (shown in Figure 5). Compared to the store managers in Denmark, store managers in the

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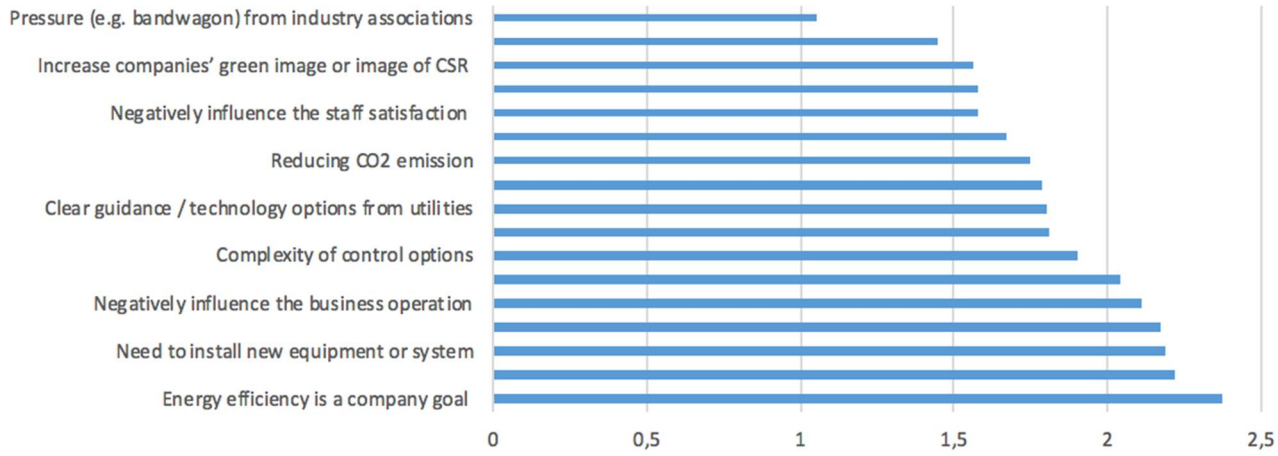
Philippines only consider 'lacking knowledge' and 'negatively influence the business operations' are important for the DR program participation.



This question used the 5-point Likert scale from '0-not important at all', '1-less important', '2- neutral', '3- slightly important' to '4-very important'.

Figure 4 Influential factors that surveyed managers consider to be important to DR program participation. N=87

Table 2 Top Influential factors and the correspondent aspects

Aspects	Top influential factors
Business	• Energy efficiency is a company goal • Dynamic control can negatively influence the business operation • Dynamic control can negatively influence the customer satisfaction (e.g. comfort)
Technology	• Need to install new equipment or system • The company is Lacking knowledge
Financial	• The ROI (Return on Investment) of installing the automatic control system

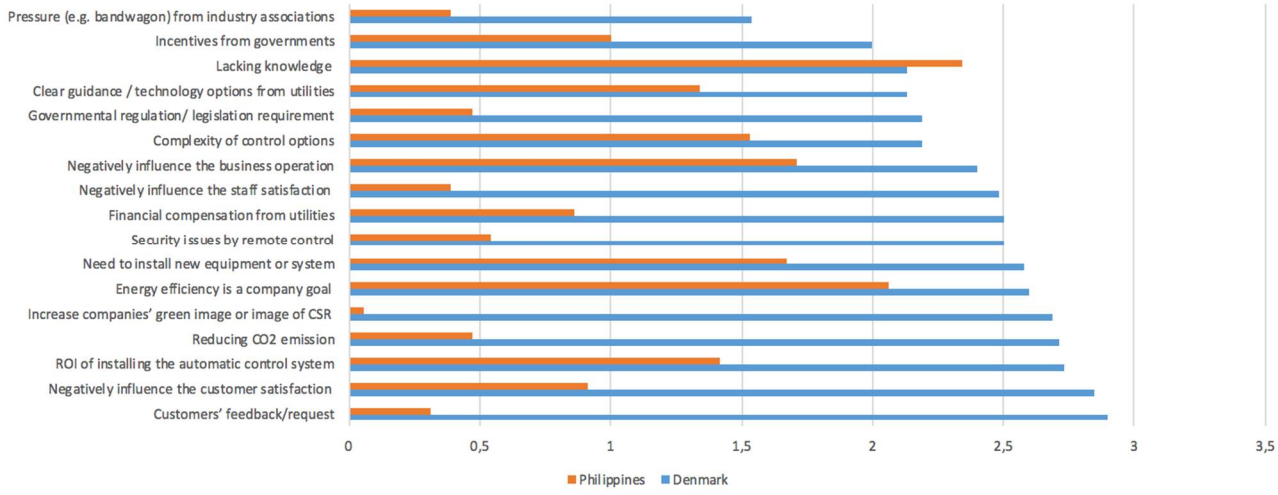


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Figure 5 The comparison of influential factors that surveyed managers consider to be important to DR program participation N = 51 (Denmark), N = 36 (Philippines).

3. Stakeholders' participation

3.1 Employees' participation of the DR activities

Literature [35] shows that some of the DR activities affect staffs rather than customers, and staffs are not actively involved in the DR activities. The surveyed result (Figure 6) shows that the majority of store managers think employees should be informed regarding DR activities, but they do not think employees should be involved in either the DR strategies or be rewarded for their involvement. Meanwhile the survey result (shown in Figure 7) shows, 51% of store managers in Denmark think that employees should involve in the DR strategies, and only 5.6% of store managers in the Philippines believe that employees should involve.

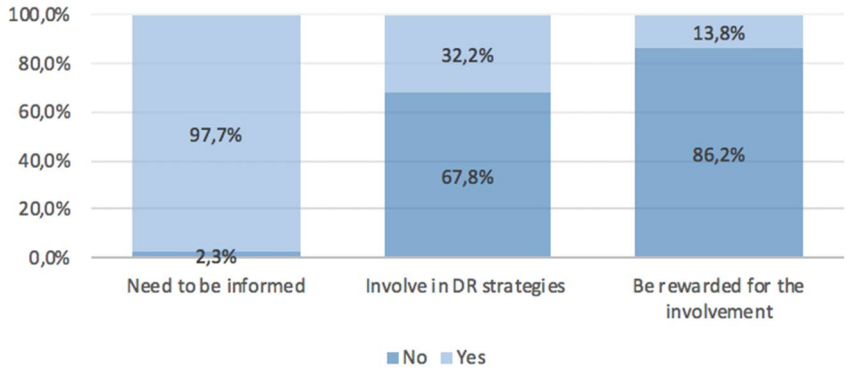

Figure 6 The percentage of surveyed managers' opinions on if the employees should be informed of DR activities, involved in the activities or rewarded of the involvement in the activities. N = 87

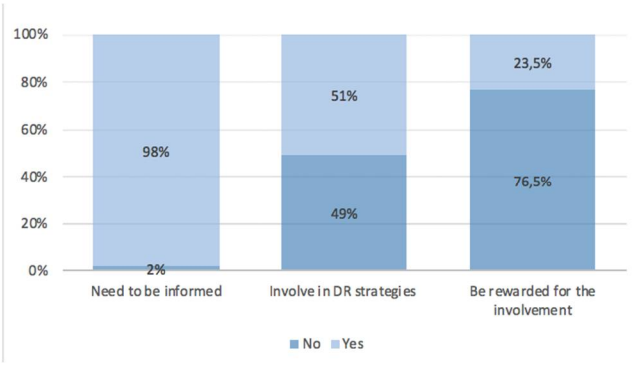

Figure 7a the percentage of surveyed Danish managers' opinions on employees' participation in the DR program. N=51

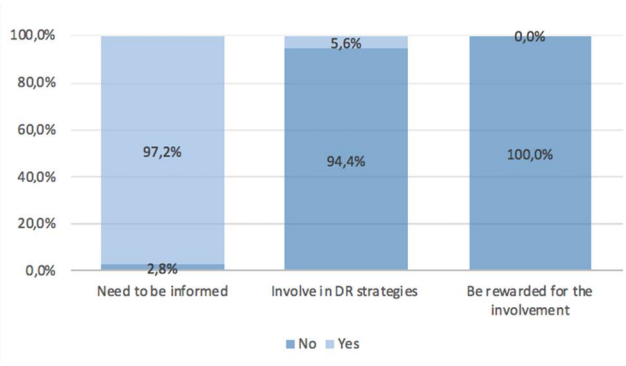

Figure 7b the percentage surveyed Philippines managers' opinions on employees' participation in the DR program. N=36

Of the surveyed store managers, 78.6% believe that employees cannot tolerate the frequent indoor comfort changes by the dynamic control. Yet, 97.7% of the store managers do not think employees should get compensation to reduce their dissatisfaction (Figure 8). In Denmark, 62.7% of the surveyed store managers believe that the dynamic control will decrease employees' satisfaction, whereas only 13.9% of store managers in the Philippines believe the same (Figure 9). On the contrary, more store managers in the Philippines (90.9%) believe employees cannot tolerate the frequent indoor comfort changes through dynamic control compared to Denmark (70.6%).

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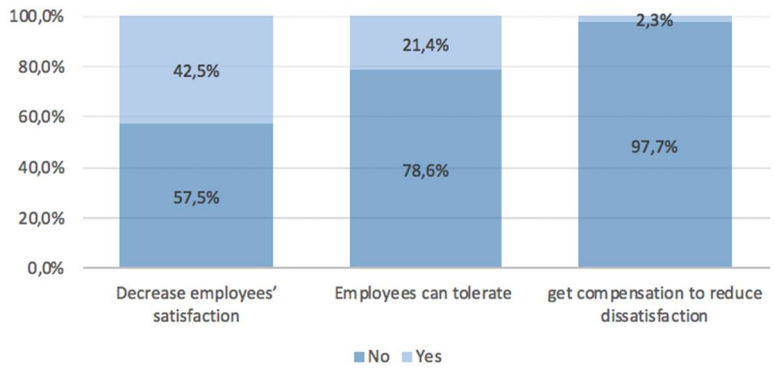

Figure 8 The percentage of surveyed managers' beliefs on employees' satisfaction due to dynamic control. N=87

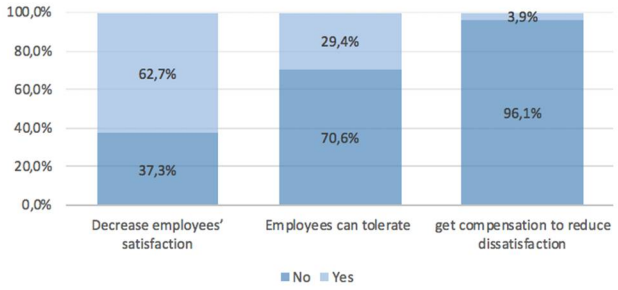

Figure 9a the percentage of surveyed Danish managers' beliefs on employees' satisfaction due to dynamic control. N=51

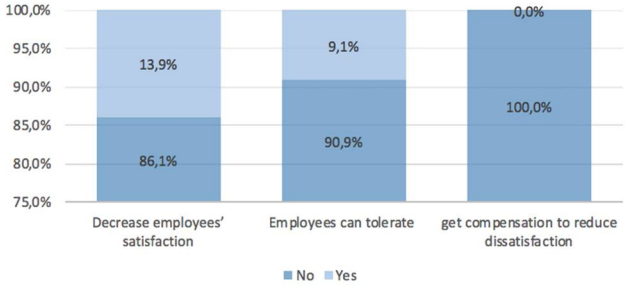

Figure 9b the percentage of surveyed Philippines managers' beliefs on employees' satisfaction due to dynamic control. N=36

3.2. Customers' participation in the DR activities

Of all surveyed store managers, 86.2% think that it is necessary to inform customers about DR activities in stores (Figure 10). However, 74.7% of them do not believe that advertisement of store energy program can increase customers' acceptance of frequent indoor comfort changes, and 77% of them believe that customers' in-store engagement/experience of the energy program cannot increase customers' acceptance of frequent indoor comfort change. Compared to the Philippines, store managers in Denmark consider more advertisement and in-store engagement can increase customers' acceptance of indoor comfort change (shown in Figure 11).

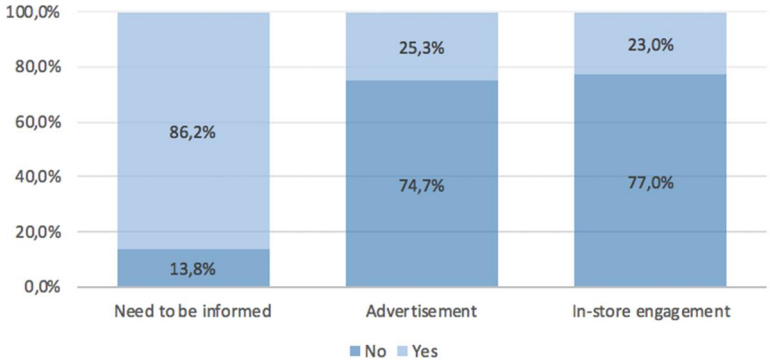

Figure 10 The percentage of survey managers' opinions regarding customers' reaction to the DR activities in stores. N=87

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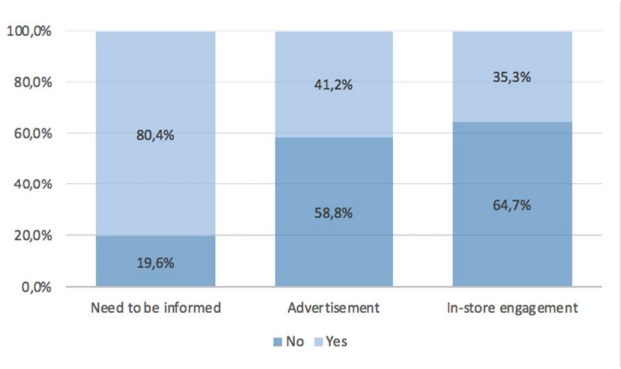

Figure 11a the percentage of surveyed Danish managers' opinions regarding customers' reaction to the DR activities in stores. N=51

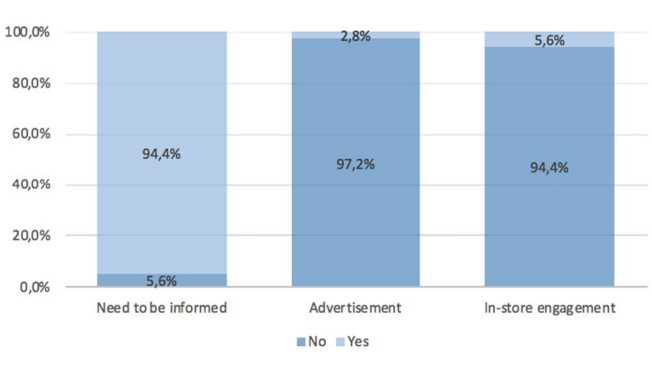

Figure 11b the percentage of surveyed Philippines managers' opinions regarding customers' reaction to the DR activities in stores. N=36

3.3 Utility companies' participation in energy management of retail stores

Figure 12 shows, 50% of the surveyed store managers in Denmark have received information regarding energy saving from the utilities, and 30% have received information regarding programs or solutions for reducing energy bills. The compensation for using less or more energy during a period is the least information received from the utilities. The reason may be due to the absence of the DR market in Denmark. Compared to Denmark, store managers in the Philippines have received no information from the utilities. In the Philippines, electricity consumers receive information regarding electricity outage via media, not from the utilities.

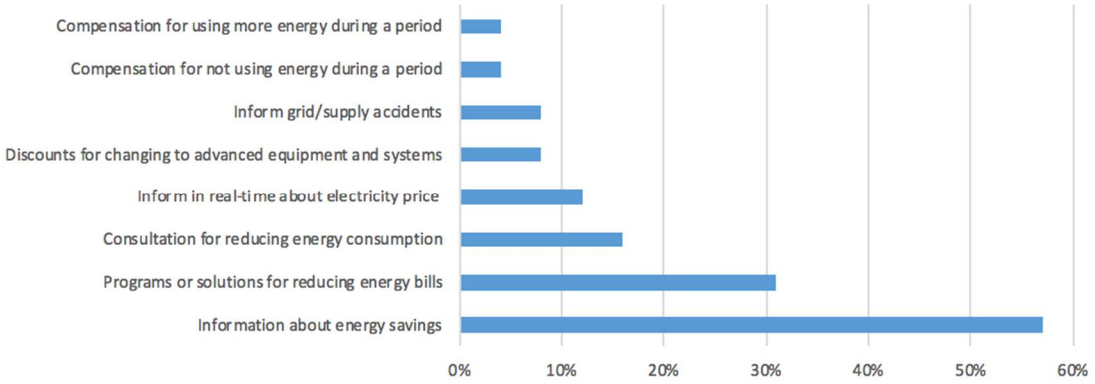

Figure 12 The percentage of surveyed managers' opinions regarding information received from utilities in Denmark. N = 51.

Figure 13 shows, in general, more percentage of store managers in the Philippines expect information received from utilities compared to Denmark, maybe due to lack of information/communication from the utilities. The main concern for store managers is energy saving. Therefore, store managers expect utilities can inform more regarding 'information about energy saving' and 'consultation for reducing energy consumption'.

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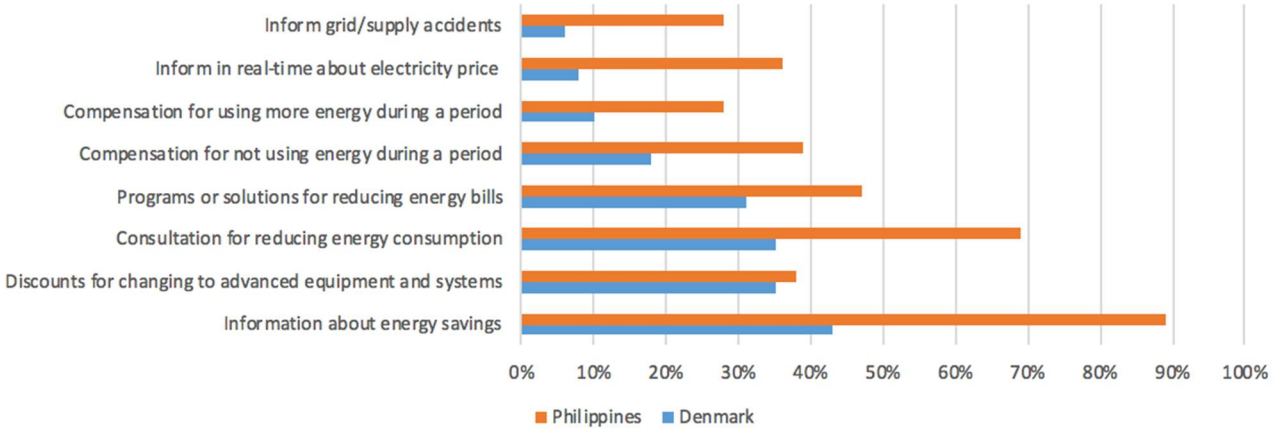

Figure 13 The percentage of surveyed managers' opinions regarding expectation to the utilities. N = 51 (Denmark), N = 36 (Philippines).

V. CONCLUSIONS

This paper investigates the readiness of retail stores to participate in the DR programs with three aspects: energy control preferences, stakeholder engagement and cross-national differences. The result shows retail stores prefer manual energy control compared to utility control or building automation. The main reasons are due to the potential interference of retail stores' business activities caused by the energy control. Retail stores' concerns related to the manual control preferences are equipment damage, saving bills, indoor temperature and indoor lighting.

There are six factors that retail stores believe important to the DR participation. They are company goal, lacking related knowledge, new equipment installation, ROI, business operation and customer satisfaction. Surprisingly, legal and environmental factors are not believed by the retail stores as important factors to the DR participation.

Regarding stakeholder engagement, the result shows, retail stores believe that their employees and customers should be informed regarding stores' DR participation, due to the potential interference of employees' working environment and customers' shopping experience. However, retail stores prefer not include either their employees or customers in the DR strategies or activities. Meanwhile, retail stores have mainly received and expect to receive more information regarding energy bill reduction or energy saving from the utilities. This result shows, the focus of retail stores are still energy efficiency, not energy flexibility. The financial benefit is the main reason.

This paper finds out that there are significant differences regarding the energy control preferences and concerns between retail stores in Denmark and the Philippines, but no significant difference regarding stakeholder engagement. The differences are mainly due to the different energy supply situations across the two countries. For instance, there is increasing energy demand in the Philippines that still cannot be fulfilled. Therefore, the urgent need in the Philippines is not creating the energy flexibility market but increasing the energy production. Meanwhile, the insignificant difference regarding stakeholder engagement presents the similarity of the same sector across countries.

Although the literature has discussed the potentials and benefits of energy flexibility in retail buildings from theoretical and technical perspectives, the investigation of retail stores' DR participation in this paper shows, retail stores in either Denmark or the Philippines have not been ready to provide their energy flexibility to the grid. Literature shows that DR control options are mainly influenced by retail stores' capacity of providing energy flexibility. The result of this paper reveals that retail stores concern more about business operations and financial benefits compared to the technic potentials or constraints.

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By uncovering retail stores' concerns and willingness towards DR participation, this paper also contributes to developing potential business models for retail stores to participate the DR programs based on their preferences and constraints (shown in Figure 14). The research results not only fill the theatrical gap of retail stores' DR participation but also provide managerial knowledge to stakeholders in the DR market, e.g. aggregators and utilities.

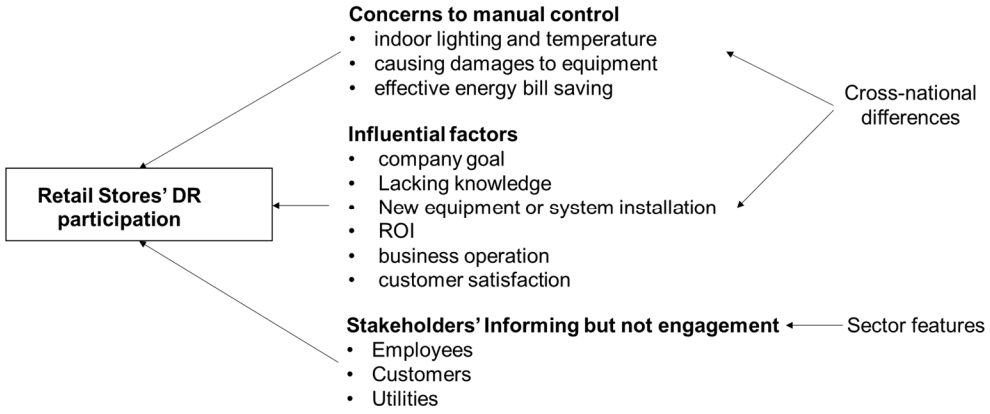

Figure 14 Framework of retail stores' demand response participation

DR is believed as a collective innovation in the smart grid. However, this paper focuses on the retail stores' perspective. Although the results show that retail stores prefer to not directly engage other stakeholders in the DR activities, other stakeholders' opinions and preferences still need to be considered. Therefore, future research is recommended to focus on different stakeholders that provide different angles to the retail stores' DR participation.

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