Master's Degree in **Systemic Design** | Politecnico di Torino
Academic Year 2024/2025

Politecnico di Torino

Thesis project by **Benyu Hu**
Supervised by **Silvia Barbero, Wen Lu**

Systemic Design to Promote Sustainable Healthy Eating for School-Age Children

An Example Based on Urban Areas in Wuxing District, Huzhou, Zhejiang

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To my beloved family, my source of light, courage, and grace.

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Abstract

Unhealthy dietary behaviors among Chinese school-age children are contributing to rising obesity and chronic disease, underscoring the need for sustainable interventions. This study examines how school food systems, family environments, and institutional structures shape eating habits, using Wuxing District in Huzhou as a representative case.

Employing a systemic design approach, the research conducted a holistic diagnosis and developed a phased, multi-stakeholder intervention roadmap. Fieldwork at a pilot public middle school revealed key issues such as high food waste, limited meal personalization, and weak stakeholder feedback.

In response, the project developed prototype interventions including participatory food education, family and peer-based strategies, behavior-shaping campus installations, and partnerships with local food networks. These efforts improved nutrition awareness, student engagement, and cross-sector collaboration.

Introduction

1.1 | *Research background and significance*

According to a study published in the European Heart Journal in 2023 that analyzed diet, cardiovascular disease, and mortality across 80 countries (Mente et al., 2023), along with the Global Burden of Disease Study (GBD), which examined the impact of dietary risks on health in 195 countries from 1990 to 2017 (GBD 2017 Diet Collaborators, 2019), China's healthy eating index falls below the global average, which has led to a steady increase in chronic diseases such as obesity, cardiovascular disease, and diabetes. This phenomenon is likely closely tied to China's rapid economic growth, accelerated urbanization, lifestyle changes, and food consumption pattern adjustments (Zhang et al., 2022).

However, the formation of healthy eating habits begins in childhood. Good nutrition is the cornerstone of lifelong health. Establishing healthy dietary habits early in life is crucial—not only does it reduce the risk of chronic diseases, but also fosters a healthy lifestyle and promotes comprehensive physical and mental development (Haines et al., 2019). China's rapid environmental changes have placed children in a passive position, where their dietary choices and access to information are heavily influenced by external factors, often lacking sufficient autonomy and access. In this context, nutrition education for children and adolescents becomes essential.

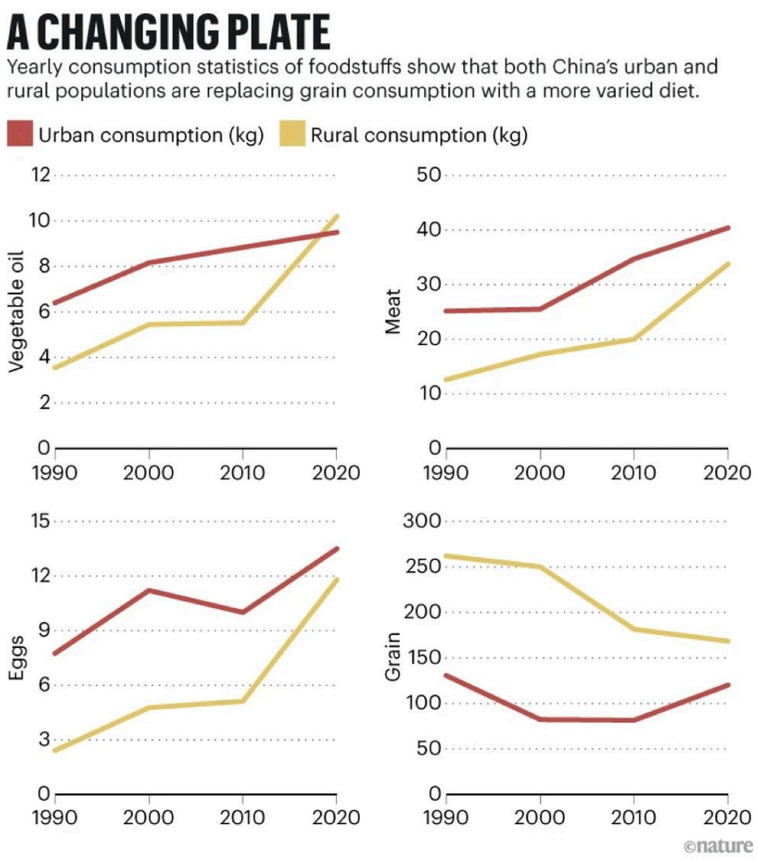
From the perspective of sustainable economic, social, and environmental development, personal dietary habits are intricately linked with the food industry, nutritional science, public health, and ecosystems (Alsaffar, 2016). Establishing and promoting sustainable food production and consumption models and advocating for healthy and balanced diets improves individual health outcomes and contributes to sustainable development across economic, social, and environmental dimensions (Zhang et al., 2022).

The trend toward eating diverse natural foods and considering

environmental impacts has become part of modern dietary guidelines (Mente et al., 2023; Kiani et al., 2022; Serra-Majem et al., 2020). This trend also aligns with three United Nations Sustainable Development Goals (SDGs), including Goal 2: Zero Hunger, Goal 3: Good Health and Well-Being, and Goal 12: Responsible Consumption and Production *(United Nations [UN], 2015)*.

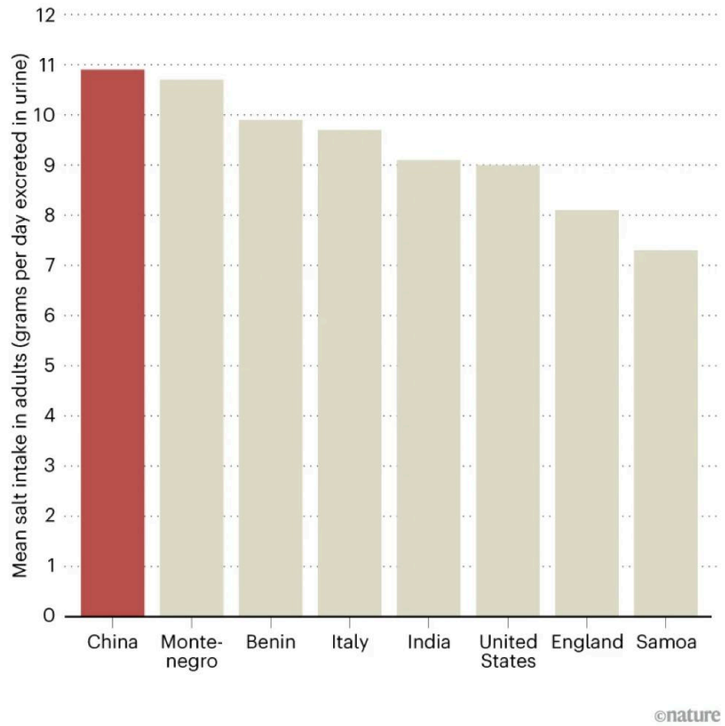
Between 1987 and 2017, China experienced significant changes in food production and consumption patterns due to rapid urbanization and economic growth. Greenhouse gas emissions from food production increased by 51%, and food consumption rose by 64%, primarily driven by higher demand for animal-based foods. While replacing domestic production with imports has helped reduce domestic food-related emissions, the global environmental impact remains significant. Thus, shifting toward healthier dietary patterns offers a feasible opportunity to reduce domestic and international environmental pressures (Zhang et al., 2022). On the other hand, a prospective study involving 134,000 Shanghai residents showed that greater adherence to the Chinese Dietary Guidelines *(Chinese Nutrition Society, 2022)* was associated with lower mortality rates (Yu et al., 2014). These studies suggest that healthier dietary structures promote human health and ecological sustainability. Moreover, valuing and preserving food diversity also contributes to safeguarding China's rich culinary heritage (Zhang et al., 2020).

However, shifting current dietary patterns in China toward healthier alternatives involves multiple challenges. Firstly, as mentioned earlier, dietary structures have changed significantly, with sharp increases in meat consumption leading to excessive fat and oil intake. A study involving 12,814 Chinese adults revealed that a lack of knowledge, attitudes, and behavior related to healthy eating is significantly associated with poor health outcomes (Yang et al., 2020). Food-related biases persist due to historical economic factors—for example, whole grains are often seen as symbolic of economic hardship, while a diet high in meat and fat ("lavish meals") is perceived as a sign of economic prosperity (Chang et al., 2018). Without proper guidance, these trends in dietary changes may continue unchecked (see ***figure 1.1***).



(figure 1.1) A changing plate (Ye & Leeming, 2023a)

Excessive salt intake is also harming the health of Chinese residents. China has one of the highest average salt intakes in the world, reaching 11 grams per day. According to the World Health Organization (WHO) and the Healthy China 2030 initiative, Chinese adults' average daily salt intake is more than twice the recommended amount *(World Health Organization, 2024; The State Council of the People's Republic of China, 2019)*. WHO recommends that adults consume less than 5 grams of salt daily to prevent hypertension and reduce the risk of cardiovascular disease. However, cardiovascular disease now affects more than 300 million people in China (Ye & Leeming, 2023a) (see ***figure 1.2***).

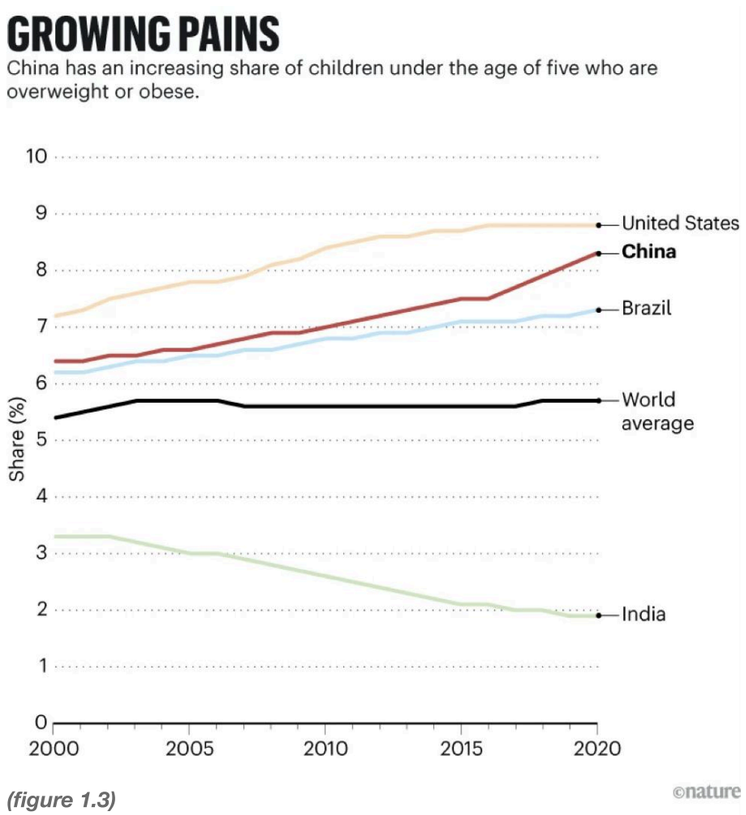


(figure 1.2) A pinch or a pound (Ye & Leeming, 2023a)

The modern food market also poses challenges. The proliferation of ultra-processed foods and food delivery services has made unhealthy food more accessible. Increased intake of ultra-processed foods is associated with metabolic syndrome and health problems such as overweight/obesity, hypertension, and type 2 diabetes (Pan et al., 2023). Additionally, food delivery services have changed people's eating and consumption habits, posing risks to public health and family meal interactions (Maimaiti et al., 2018).

Another point worth noting is a problem specific to China. Most clinical nutrition research worldwide is conducted in Western countries, and due to genetic differences and lifestyle variations, findings from these studies are not always directly applicable to the Chinese population (Ye & Leeming,

2023b; Zheng, 2023). For example, the Body Mass Index (BMI) is a widely used indicator for determining whether a person is underweight, healthy, overweight, or obese. However, research has shown that Chinese individuals are more vulnerable to the effects of obesity on blood pressure and other cardiovascular risk factors compared to other ethnic groups. For every one-unit increase in BMI, the risk of metabolic diseases like diabetes increases significantly among Chinese people. This issue highlights a gap in China's research and discourse.



(figure 1.3)

Growing pains (Ye & Leeming, 2023a)

In this context, school-age children (ages 3–18), who are at a crucial stage of development, are in a passive position regarding dietary choices. Statistics show that the 2–17 age group in China has the lowest healthy diet index among the population (Yuan et al., 2017). They face issues such as nutritional deficiencies, lack of food diversity (Meng et al., 2018), high

sugar intake (Yuan et al., 2017), and obesity (Tang et al., 2018). China is among the countries with the highest proportion of overweight and obese children under the age of five (Ye & Leeming, 2023a) (see ***figure 1.3***). According to a 2020 report from the National Health Commission of China, nearly 20% of school-age children are overweight or obese. Researchers estimate that without effective intervention, over 30% of school-age children nationwide may be overweight or obese by 2030 (Ye & Leeming, 2023b). This trend contradicts the increased nutritional needs during this critical cognitive and physical development phase (Benton, 2010).

Studies have shown that poor health in early childhood can cause permanent damage, while greater investment in child health can lead to favorable demographic changes (Belli, 2005). The Lancet Global Health Commission and the Global Accelerated Action for the Health of Adolescents (AA-HA!) initiative pointed out that investing in adolescent health and well-being yields a "triple dividend"—benefiting the present, adulthood, and the next generation (van Sluijs et al., 2021). From a broader developmental perspective, there is no better way to break the cycle of poverty and inequality than by investing in children (Danziger & Waldfogel, 2000).

1.2 | *Research objectives and questions*

Given the importance of improving dietary health among school-age children in China, this study aims to identify the key factors influencing children's eating behaviors and habits. It applies a systems design approach to explore potential intervention pathways and proposes sustainable and systemic innovation recommendations to help school-age children develop sustainable healthy eating habits.

Global trends advocate for the consumption of diverse, natural foods with consideration for ecological impact, aligning with both nutritional and sustainable development goals. However, in China, rapid modernization and urbanization have negatively impacted human health and the ecological environment. Furthermore, the general public lacks dietary health literacy, with growing children exhibiting the lowest diet health index. Against this background, this study takes the urban area of Wuxing District, Huzhou City, Zhejiang Province, as a case study to conduct a focused and

(figure 1.4) by Yikun Wang

experimental investigation into the following specific issues:

- Identify the key factors influencing the formation of healthy eating habits in school-age children.
- Analyze how to systematically intervene in these key factors, considering geography, culture, social relationships, market forces, and policy contexts.
- Determine the appropriate age range for interventions based on children's life and cognitive development patterns, emphasizing progressive and phased intervention strategies.
- Highlight the value of ecological sustainability and cultural diversity within the proposed intervention strategies.

1.3 | *Research scope*

This study focuses on the mechanisms behind the formation of dietary behavior and healthy eating habits among school-age children in China, with an in-depth analysis and design-based intervention conducted using the urban area of Wuxing District, Huzhou City, Zhejiang Province, as a case study.

The research focuses on school-age children in urban areas, exploring factors influencing their dietary behaviors, such as family structure and parenting methods, school education, social culture, and the food market environment.

The study selected Wuxing District due to its representative economic, educational, and quality-of-life conditions. Residents here have moderately high income and consumption levels, relatively abundant educational resources, and active parental involvement in children’s education. Additionally, the region features distinct dietary traditions (e.g., light taste preferences, favoring aquatic foods, emphasis on seasonal ingredients), providing a strong foundation and moderate challenges for dietary health intervention experiments.

The study adopts a systems design approach that integrates knowledge from nutrition and health, socio-cultural studies, behavioral science, and sustainable development. From the perspectives of social relationships, geographical environment, policy orientation, market mechanisms, and cultural values, it identifies the key factors shaping children’s dietary habits and explores comprehensive intervention strategies.

Special attention is given to adapting interventions to different age stages, implementing recommendations in a phased manner, and incorporating ecological sustainability and cultural diversity values.

Rather than aiming for nationwide data coverage, this study is grounded in regional case analysis to provide systemic ideas and feasible approaches for broader healthy dietary education and intervention programs.

(figure 1.5) Wuxing District, Huzhou City, Zhejiang Province, China

Reviews of Current Research

2.1 | *Sources and methodology*

Three types of information sources contribute to the current situation analysis in this study:

- Academic Literature: High-quality and recent studies related to the research topic were systematically retrieved using medical databases such as PubMed and BMC Medicine and general academic search engines like Google Scholar.

- Guidelines and Policies: Nutritional and dietary guidelines published by international and Chinese governmental and authoritative institutions.

- Industry Reports: Information from food industry news websites, such as FoodTalks Global Food Information Network, was used to track market trends and dynamics.

These sources provide a solid academic, policy, and practical foundation for the study. However, the study does not elaborate on the search terms or results from grey literature databases. Topics reviewed include, for instance, the role of family meals in influencing children's eating behaviors and schools as supportive environments.

2.2 | *Family Meals and Children's Eating Behavior*

Unhealthy eating behaviors are common among Chinese school-age children, including picky eating, inadequate food intake, refusal to try new foods, inconsistent mealtimes, eating while distracted, emotional eating, and excessive consumption of high-calorie and high-sugar foods (Zhang et al., 2021).

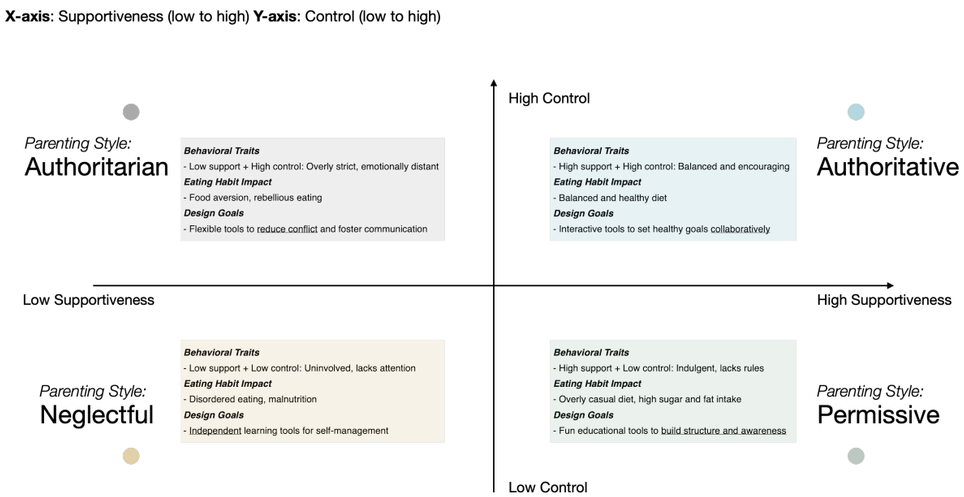
Research shows that parents' eating habits and feeding strategies influence children's eating behavior and food choices (Scaglioni et al., 2018). Food providers' nutritional literacy links to children's health and dietary patterns (Chang et al., 2022). Additionally, there is a significant resemblance between parents' and children's food preferences, especially when the parent responsible for meal decisions plays a dominant role (Vepsäläinen et al., 2018).

In single-parent families in China, parents often compensate their children with food or money (Tian & Wang, 2019). The lack of shared responsibilities significantly reduces opportunities for family cooking, group meals, and physical exercise (Duriancik & Goff, 2019), which increases the risk of childhood obesity and unhealthy diets. In contrast, in two-parent families—regardless of whether both parents work—mothers are primarily responsible for preparing meals (Schnettler et al., 2017).

(figure 2.1) by Tyson

Four main parenting styles are categorized based on how demanding and responsive parents are to their children: authoritative, authoritarian, permissive, and neglectful (Pearson et al., 2010; Lopez et al., 2018). Authoritative parents are most effective at promoting family meals. They set regular mealtimes and use those times for food education, such as limiting high-calorie foods and encouraging healthy eating. Other parenting styles often lack structured food education. For example, authoritarian parents may enforce mealtime rules but fail to create an environment conducive to parent-child interaction, while permissive and neglectful parents typically do not establish any structure for mealtimes (Lopez et al., 2018). In addition, fathers are more likely than mothers to adopt a permissive parenting style (Scaglioni et al., 2018).

The four parenting styles can be mapped on a support (x-axis) and control (y-axis) quadrant. High-support, high-control Authoritative parenting is ideal, favoring collaborative interventions. Authoritarian benefits from conflict-reducing approaches. Permissive parenting requires structured, awareness-building interventions, while Neglectful parenting requires cultivating children's independent learning and self-management (see ***figure 2.2***).



(figure 2.2) Created by the author

2.3 | *The role of schools*

A study on the prevention of obesity among school-aged children indicates that relying solely on parental education—without promoting supportive environmental and policy changes—results in limited effectiveness of dietary interventions (Lambrinou et al., 2020). Social networks, such as peer interactions, also play a critical role in shaping the dietary habits of school-aged children. A longitudinal study on household dietary changes revealed that while parents made greater progress toward healthy eating when children's social networks lacked support, the children themselves showed minimal dietary improvements (He et al., 2015; Ma et al., 2019; He et al., 2019; He et al., 2022; Sun et al., 2022). These studies suggest that although families significantly influence children's development, such influence may be negligible if the surrounding environment is unsupportive. Therefore, examining which factors contribute to creating a supportive environment is essential.

(figure 2.3) by Keren Fedida

Eight cases examine the elements of supportive environments provided by different settings and organizers in the context of dietary education for children. To identify their characteristics, categorized into school-based and community-based environments (He et al., 2015; Ma et al., 2019; He et al., 2019; He et al., 2022; Sun et al., 2022; Ishikawa et al., 2018; Miyoshi et al., 2012; *Eto et al., 2019; Good Food Fund, 2022*). The school-based environments included School-EduSalt, the Sakadoshi Shokuiku Program, Nanjing Puyu Ecological Technology Co., Ltd., and Joyoung's Food Education Workshop (see ***figure 2.4***). The community-based environments included Chuanjia International Eco-Village, Zhiben Shiyi, Delicious Nature Food Education School, and Xiaoxumiao (see ***figure 2.5***).

School-based

(figure 2.4) Created by the author

The analysis revealed that schools are distinctive in offering extended periods of peer interaction, providing meals and educational curricula, and having a relatively complete catering system. Peer networks and social relationships significantly influence children's dietary behaviors, and educators must also pay attention to their psychological development. Because it is a collective occasion, resources that are limited in quantity and sophistication need to be shared. What schools can provide is uniform and efficient, but each student has different characteristics, comes from different family backgrounds, and has different parenting methods. Facing a large and diverse student population also requires more trained teachers to care about each student's nutrition and psychological status.

In contrast, community-based activities are marked by active parental involvement, with parents intentionally engaging their children in such programs, reflecting their proactive expectations. These activities are engaging, provide rich experiential learning, and allow for more personalized attention. Joint participation by parents and children can further enhance educational outcomes. However, the short-term nature of these initiatives limits their overall impact. Moreover, it is also impossible to track their effects in a long-term and stable manner.

Community-based

(figure 2.5) Created by the author

2.4 | *Market insights*

Based on market research, there are seven categories of approaches to improve the diet of school-age children:

(a) Healthy foods, drinks, and nutritional supplements for school-age children;

(b) Books, materials, and apps for parents to plan healthy family meals;

(c) Apps specifically aimed at improving diet and developing healthy eating habits;

(d) Children's books on healthy eating education;

(e) Gamified dietary education apps for children;

(f) Interactive toys or tools designed for children's healthy eating education;

(g) Educational courses on healthy eating organized by food companies or health promotion organizations.

Two evaluation criteria were used to analyze the similarities and differences across these product types: the impact on children's education and the direct or indirect contribution to health outcomes. Assessments of categories (d), (e), (f), and (g) show that interactive approaches are more effective and that older school-age children benefit more from educational interventions. Comparisons between categories (a), (b), and (c) and those in (d), (e), (f), and (g) suggest that direct health impact requires products to focus more on actual food intake rather than just theoretical knowledge. Overall, there is a lack of products on the market that have high educational value and directly improve health outcomes.

2.5 | *Summary of current situation*

Interventions to promote better dietary patterns in school-age children come from various linked sources: academic research (intellectual products), institutional programs, and market-based innovations. All of these levels of influence make a distinct contribution to determining children's eating behavior.

Within this ecosystem, the family and school environments emerge as the most immediate and influential contexts in which dietary behaviors are learned, reinforced, or neglected. Parents and caregivers shape children's food preferences and access through day-to-day decisions on meals and snacks and their attitudes to nutrition. Schools also have an important function in distributing meals through school lunch programs, teaching kitchen literacy, organizing health-promoting activities, and modeling favorable food environments in cafeterias.

At the same time, the market is teeming with an increasing number of supplementary tools and interventions—a wide variety of gamified nutrition apps, cookbooks aimed at kids, branded meal kits, and educational toys intended to encourage healthy food engagement. Even with these comprehensive approaches, there is still a big gap between nutrition education and behavior change. Awareness per se does not result in sustained changes in a diet. This gap is frequently attributed to the absence of evidence-based and scalable interventions but also fun, accessible, and sensitive to children's lived experiences and developmental needs.

Importantly, a few existing interventions pay too little attention to the role of motivation and agency in children's eating. Even the best-intentioned programs can fall short if we do not have things that encourage curiosity, pleasure, and a sense of autonomy. Lasting change is needed, not just instructive messages, but active means for children to take responsibility for their learning. Hence, future design and policy interventions cannot rely on top-down approaches but must focus on feasibility, interaction, and flexibility. These characteristics are necessary to incorporate healthful eating habits into daily living patterns and to fit the varied social, cultural, and economic contexts in which children develop.

Solving such a wicked problem requires a systems-level approach across families, schools, communities, healthcare providers, designers, and the private sector that is iterative and collaborative. Effective development of sustainable, healthy eating habits in children is such a multi-stakeholder ecosystem that it continuously fine-tunes itself for feedback, learning, and testing to provide better support for forming long-term behaviors around eating. This model should be grounded on nutritional science, didactical perspectives, factor play, personalization, and emotional engagement as its design principles. Only then can we even dream of closing the remaining chasm separating what we know about diet from what we do about it.

Research Methods

3.1 | *Systemic design as an approach*

Interpretation of “Systemic Design” has varied widely through academic and professional use. This study precisely alludes to the Systemic Design (SD) model of Professor Luigi Bistagnino (Bistagnino, 2011), creator of the Master of Science (MSc) in Systemic Design at Politecnico di Torino. His introduction to SD as one of the few early SD design approaches was in reaction to the complexity and unsustainability of linear Mass Production-based design systems. Instead, it promoted an ecosystemic, holistic strategy based on observation of natural systems.

According to the Sys Lab, “The Systemic Design configures like a Cultural Method that considers the relations among the parts of a system as the triggers of the system. It studies the dynamics of nature to create systems more influenced by the exchange of matter, energy, and information. By doing this, what is the input for one process becomes the output for the former, preventing waste and generating added value” (Sys Lab, n.d.).

This orientation represents a profound reorientation away from designing discrete products and services to designing systems of interacting processes, systems that are not only designed to operate effectively but also to self-renew, self-enhance, and co-evolve over the system’s life.

The systemic design paradigm is rooted in several fundamental principles, most of which, as we have shown, are further elaborated upon in references. Some of the fundamental principles of this approach are the redefinition of outputs as inputs, their relational orientation, the notion of autopoietic systems, and the postulates to do locally and to ‘humanize’ design (Bistagnino, 2011; Giraldo, 2020; Maturana, 1972; Sevaldson, 2022; Norman 2023 as cited in Lu et al., 2023).

The principle of “outputs > inputs” represents the ecological reasoning governing the circular economy, whereby the waste or by-products of one system have become configured as raw materials or inputs into another. This principle supports a dynamic balance in the exchange of matter, energy, and information, creating the conditions for a regenerative cycle in which consumption and waste are minimized without depleting resources or polluting nature. It operates like natural ecosystems, in which nothing is truly discarded, and everything has a role within the larger ecological fabric.

The second principle—relationships—recognizes that the parts in a system do not achieve the identity or behavior of the system as a whole. The relationships apart entre eux of the parts are responsible for their identity and behavior. These connections are then also functional and dynamic in a systemic view. They modulate the fate of the system, and in turn, they are modulated, leading to emergent phenomena and properties that cannot be predicted starting from the analysis of the individual components.

Third, autopoiesis is crucial for systemic design thinking (introduced initially by Maturana and Varela, 1972). An autopoietic system creates and recreates itself in the processes of its operation. In a design sense, this principle applies to changing social and organizational systems based on both internal requirements and external influences. Lu et al. (2023) suggest that such systems are autopoietic and inevitably political and ethical: they confront us with important questions about community agency, power relationships, and democratic governmentality. Considering such problems is critical in the design of complex, multi-actor systems such as schools, urban food networks, or healthcare ecosystems.

A second central tenet of this systems design mindset is localization. It asserts the need to ground design interventions in material, cultural, social, and economic specificities. Unlike the imposition of prescriptive answers,

systemic designers are urged to co-evolve contextually relevant and resilient systems and engage with local resources, knowledge, and networks. This local targeting makes it more relevant and efficient, helps empower the community, and increases sustainability.

Lastly, Humanity-Centered Design applies an ethical and empathetic perspective to systemic design practice. Building upon a holistic discourse on the need to respond to wicked interconnected problems—climate change, food insecurity, or public health injustice—this view broadens and proposes an extension to the user-centered design paradigm. It contextualizes human needs within larger ecological and societal structures and acknowledges that human well-being is inextricably connected to the health of our planet and the well-being of our communities. The humanistic design mode should add emotional, psychological, and cultural dimensions to the design behaviors to make the design rational not only from the functionality but also from the social justice and emotional echo. Healthy solutions should have an emotional release and human-swarm color.

In conclusion, Systemic Design (as proposed by Bistagnino and further developed here by other researchers) provides a solid base for reconsidering what we mean by designing in and for complexity. Prioritizing flows, relationships, local variation, and human experience allows for the emergence of dynamic, connected, and sustainable systems better equipped to respond to today's challenges.

3.2 | *Systemic design as a methodolgy*

Here, Systemic Design as an approach and as a methodology are intentionally differentiated. A word of difference that is not only of semantics but refers to two cooperating dimensions of Systemic Design (SD), conceptually and practically relevant.

Calling Systemic Design an approach is intended to underscore its philosophical and epistemological base - a way of perceiving, thinking about, and interpreting the world. SD implies moving from linear, simplistic thinking to holistic systems thinking. Instead, it reminds designers and researchers about interplays, feedback, and emergent dynamics in a

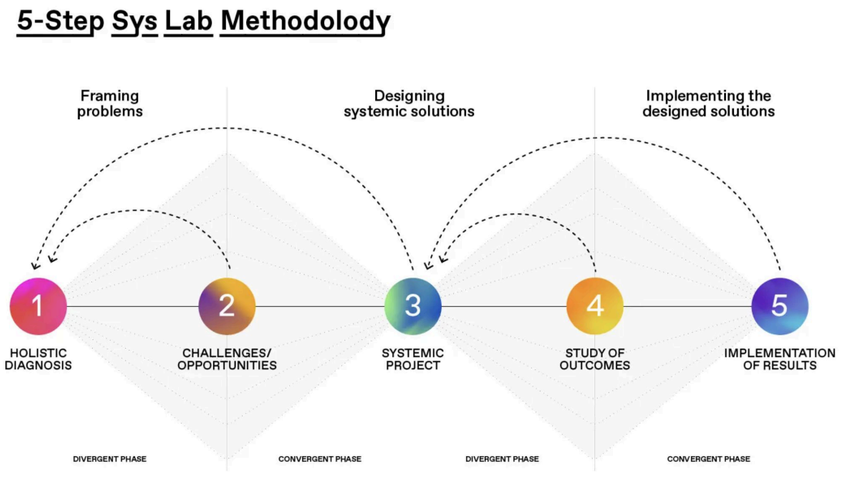
complex system. From this perspective, SD is not primarily a toolkit but a cognitive and cultural lens: a mode of inquiry affecting how problems are defined, how boundaries are constructed, and how values such as sustainability, connectedness, and co-evolution are woven into design intentions. In this respect, SD as a methodology constitutes the philosophical foundation of this research, anchoring it in a systemic way of looking at human and ecological environments.

However, Systemic Design as a method refers to its operative aspect: the codified processes, strategies, and tactics that have been systematized through decades of academic articulation and field intervention. Building on the earlier work of Bistagnino (2011) and others, systemic design is now a replicable, adaptable systemic design process with well-defined stages, tools (e.g., flow diagrams, systemic maps, actor-network representations, and so on), and heuristics to guide interventions in the real world. This methodological aspect allows designers to move away from an understanding at a conceptual level to concrete systems intervention, attempting to overcome the theory–practice divide.

Thus, this study's approach serves as the worldview and analytic foundation, and the methodology serves as the means by which this approach is realized.

Systemic Design has developed into a practical and integrative methodology to address pressing real-world issues by combining human-centered thinking with a systems-oriented perspective. The approach adopted by the Systemic Design Lab at Politecnico di Torino builds upon the design principle that "the outputs of a system become the inputs for another productive chain". Over two decades and through the implementation of hundreds of projects, this foundational idea has been progressively refined into a comprehensive methodology equipped with tools specifically designed to tackle challenges related to environmental, social, and economic sustainability (Lu et al., 2023).

Drawing upon the framework outlined (see ***figure 3.1***) by the Sys Lab (n.d.) of Politecnico di Torino and further elaborated by Lu, Pereno, and Barbero (2023), the systemic design methodology can be described as follows:



(figure 3.1) 5-Step Sys Lab Methodology (Sys Lab, n.d.)

Systemic Design employs an iterative methodology structured around alternating divergent and convergent phases. This approach unfolds through three principal stages—problem framing, systemic solution design, and implementation—supported by four key focus areas distributed throughout the process. Operationally, it comprises five distinct steps: holistic diagnosis, identification of problems and leverage points for change, systemic design, theoretical analysis of outcomes, and implementation of results.

The process begins with framing complex problems embedded within socio-technical systems—contexts often characterized by multiple and occasionally conflicting interpretations of value, impact, and priority. Design methods at this stage must navigate such ambiguity to define the system's boundaries, delineate its scope, and establish an appropriate research direction.

The first operational step, holistic diagnosis, entails collecting both qualitative and quantitative data through desk research and fieldwork. These data encompass social, cultural, economic, productive, and environmental dimensions. Visual tools—such as complexity maps—illustrate flows of matter, energy, and information while simultaneously revealing interconnections among actors and territories. This mapping

process supports interpreting systemic relationships and lays the foundation for subsequent stages.

Based on this interpretation, the process defines problems and identifies leverage points for change. Rather than isolating individual failures, this phase examines how undesirable outcomes emerge from interactions within the system. Problems are thus reframed as opportunities for transformation—critical nodes where design intervention can activate systemic innovation and uncover latent potential.

The next step, systemic solution design, seeks to construct a new configuration of optimized relationships among actors, processes, and resource flows. Central to this effort is developing a systemic matrix—a parameterized model informed by contextual characteristics. Within this framework, design interventions reconfigure materials, energy, and information flows, frequently redefining waste as a resource. The outcome of this phase is a reference model that supports iteration and evolution over time.

Before real-world application, the process incorporates theoretical studies to assess the anticipated impacts of the proposed design. These evaluations consider environmental, economic, and social dimensions at systemic and sub-systemic levels. This predictive analysis enables refinement of the proposed interventions and mitigates potential risks before implementation.

Implementation involves prototyping the systemic model within its intended context, engaging relevant stakeholders in co-constructing new relationships, and gradually modifying the existing system. This transitional phase facilitates adaptation and promotes ownership among participants.

The process concludes with an analysis of outcomes and integration of feedback. This stage evaluates the performance and impact of the implemented system across varying timeframes and scales. The iterative nature of Systemic Design ensures the incorporation of continuous feedback, enabling adaptive adjustments and long-term system evolution. Insights generated throughout the process inform future design iterations and support envisioning alternative scenarios.

Understanding Complexity

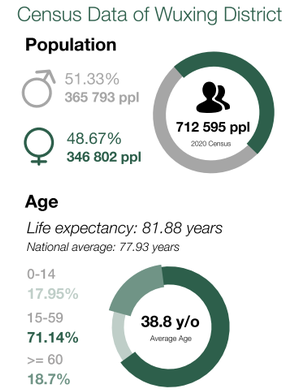
4.1 | *Holistic diagnosis of urban areas in Wuxing District, Huzhou City, Zhejiang Province, China*

A comprehensive regional diagnosis was conducted in Wuxing District, Huzhou City, Zhejiang Province, China, to provide a scientific basis and practical support for developing systematic interventions to promote healthy and sustainable eating behaviors among school-aged children. The analysis synthesized multiple dimensions, including demographic structure and dynamics, functional spatial division, historical and cultural resources, agricultural production systems, and economic and industrial composition, in an attempt to develop a panoramic understanding of the socio-ecological system of Wuxing District and to lay a solid foundation for the design of subsequent intervention strategies.

Wuxing District is located in the core region of the Yangtze River Delta Economic Circle along the southeast coast of China (see ***figure 4.1***), with an administrative area of 871.9 square kilometers, a significant locational advantage, and convenient transportation. According to the seventh national census data (Wuxing District People's Government, 2021), the district's total population is 712,595, with an urbanization rate of 73.3%, showing a highly urbanized

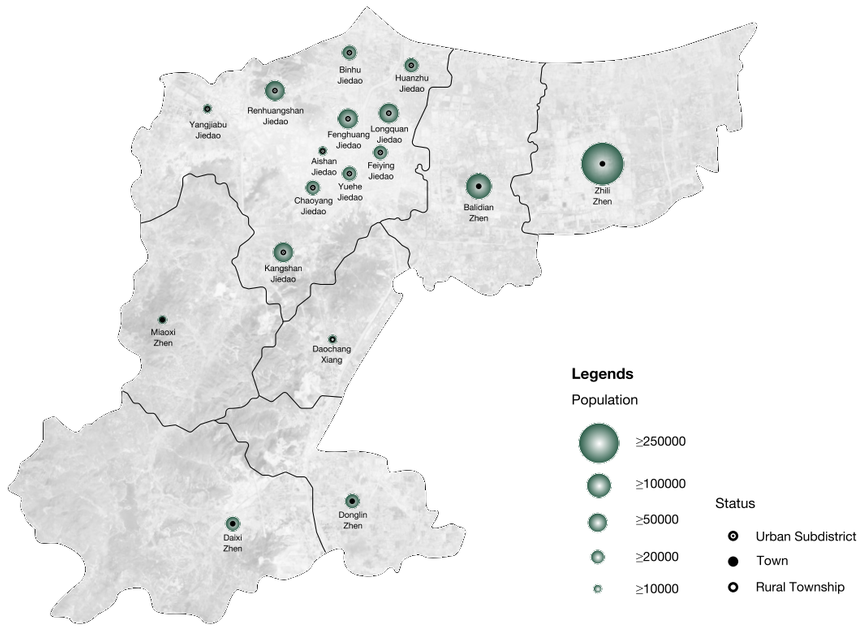
(figure 4.1) Created by the author

development trend. The gender structure is 51.33% male and 48.67% female, which is balanced. The average age of the population is 38.8 years old, with a substantial proportion of the labor force, and the life expectancy is as high as 81.88 years old (see ***figure 4.2***), which is much higher than the national average, reflecting the high level of local medical care, nutrition, and living conditions.



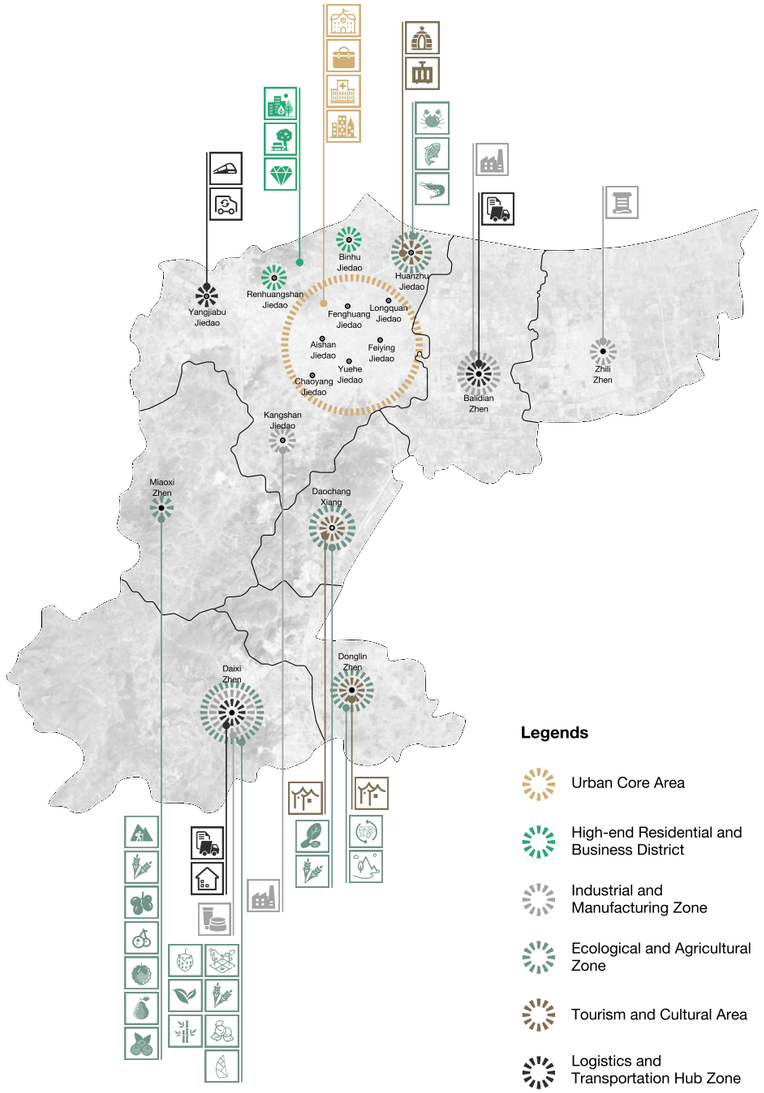
(figure 4.2) Created by the author

The population distribution is centered on the central city and Zhili Town (see ***figure 4.3***). Zhili Town attracts a large floating population due to the prosperity of its textile industry, with high population density and remarkable urban-rural integration. The main urban area, on the other hand, gathers more educational, medical, and commercial resources, epitomizing a diversified social structure.



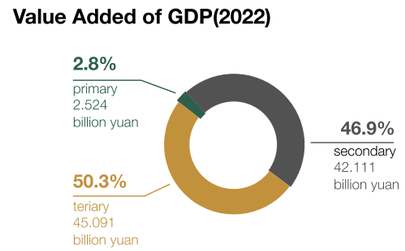
(figure 4.3) Created by the author

Wuxing District is scientifically divided into six functional zones based on functional use (see ***figure 4.4***): urban core zone, high-end residential and commercial zone, manufacturing cluster zone, eco-agriculture zone, cultural tourism zone, and logistics hub zone. This zoning layout helps promote precise planning and interventions in areas such as education, transportation, and food systems and provides spatial support for scenario-based design of children's dietary health.



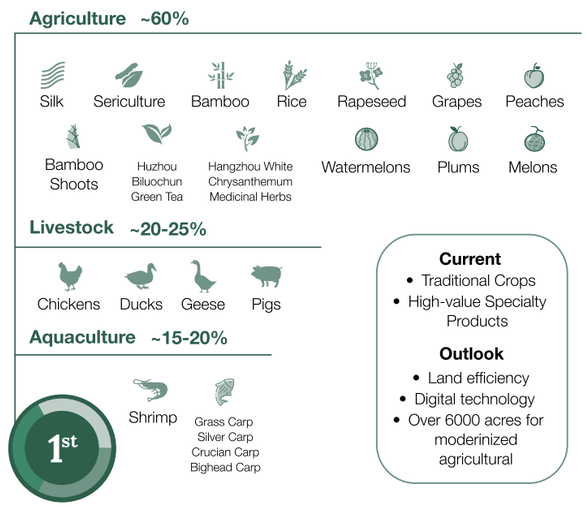
(figure 4.4) Created by the author

In terms of economic structure, according to the 2022 GDP statistics (Wuxing District People's Government, 2023), the primary sector (agriculture) accounts for 2.8%, the secondary sector (industry) accounts for 46.9%, and the tertiary sector (services) accounts for 50.3% (see ***figure 4.5***).



(figure 4.5) Created by the author

Agriculture is dominated by planting, accounting for about 60% of the total, with representative crops including raw silk, bamboo and bamboo shoots, rice, canola, grapes, peaches, Biluochun green tea, white tea, watermelon, apricots, and melons. Most of these crops are highly seasonal and nutritious, providing a rich resource base for promoting local healthy diets. Livestock and poultry farming account for about 20-25% of the total agricultural output value, covering poultry such as chickens, ducks, geese, and pigs, and realizes local self-sufficiency. Meanwhile, Wuxing District relies on the resources of the Taihu Lake water system, with fishery output accounting for 15-20% of the agricultural output, and everyday aquatic products, including shrimps, crabs, crucian carp, grass carp, etc., which are not only enriches the dietary structure of the residents but also reflects the ecological characteristics of the integration of land and water resources (see ***figure 4.6***).



(figure 4.6) Created by the author

Among the secondary industries, the textile industry in Zhili Town is the most developed, accounting for about 40-45% of the industry and contributing significantly to the regional economic growth. In addition, 25-30% of the processing and manufacturing enterprises are located in several towns and streets. In recent years, new industries such as new materials, electronic technology, and biopharmaceuticals have been attracted, injecting vitality into the diversified development of the economy (see ***figure 4.7***).

(figure 4.7)
Created by the author

(figure 4.8)
Created by the author

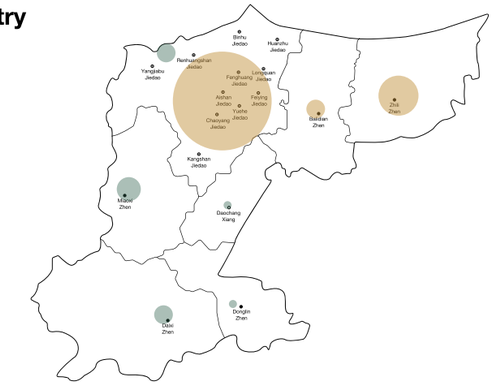
The service industry is the most important economic pillar of Wuxing District, accounting for more than half of the total, covering a variety of directions such as modern logistics, financial services, tourism, and smart city construction (see ***figure 4.8***). Among them, the study particularly concerns the catering industry (see ***figure 4.9***)- there are about 750 food and beverage stores in the district, mainly located in the central city and Zhili Town, and another 116 operators involved in agritourism and farm-to-table experiences in mountainous areas and scenic spots. These restaurants provide diversified choices for residents and tourists and assume the potential space for cultural dissemination and nutritional education.

Food and Beverage Industry

The data is sourced from the Dianping website

Approx. 750
food and beverage operators
including a diverse range of restaurants, cafes, fast food outlets, and specialty dining establishments

Approx. 116
operators involved in agritourism and farm-to-table experiences
including family farms, rural restaurants specializing in local cuisine, and businesses offering fruit picking and other agricultural activities



CLASSIFICATION

Local Cuisine	Authentic Jiangzhe Cuisine(本帮江浙菜), Farm-to-Table Cuisine(农家菜), Home-style Dishes(家常菜)
Regional Chinese Cuisine	Sichuan Cuisine(川菜), Cantonese Cuisine(粤菜), Hunan Cuisine(湘菜), Beijing Cuisine(北京菜), Northeast Cuisine(东北菜), Xinjiang Cuisine(新疆菜)
International Cuisine	Western Cuisine(西餐), Japanese Cuisine(日本菜), Korean Cuisine(韩国料理), Southeast Asian Cuisine(东南亚菜)
Casual and Thematic Dining	Buffets(自助餐), Hot Pot(火锅), Barbecue(烧烤烤串), Snacks & Fast Food(小吃快餐), Noodle Shops(面馆), Grilled Meat(烤肉), Crawfish(小龙虾), Rice Noodles(螺蛳粉), Vegetarian(素食), Dim Sum(早茶), Health Supplements & Food(食品滋补)
Specialty and Creative Cuisine	Specialty Dishes(特色菜), Private Kitchen Dishes(私房菜), Creative Cuisine (创意菜)
Seafood & Fresh Produce	Fresh Fruits(水果生鲜), Fresh Fish(鱼鲜)
Beverages and Snacks	Bakery & Drinks(面包/饮品), Cafés(咖啡厅), Bars(酒吧), Beverage Shops(饮品店), Tea Houses(茶馆)

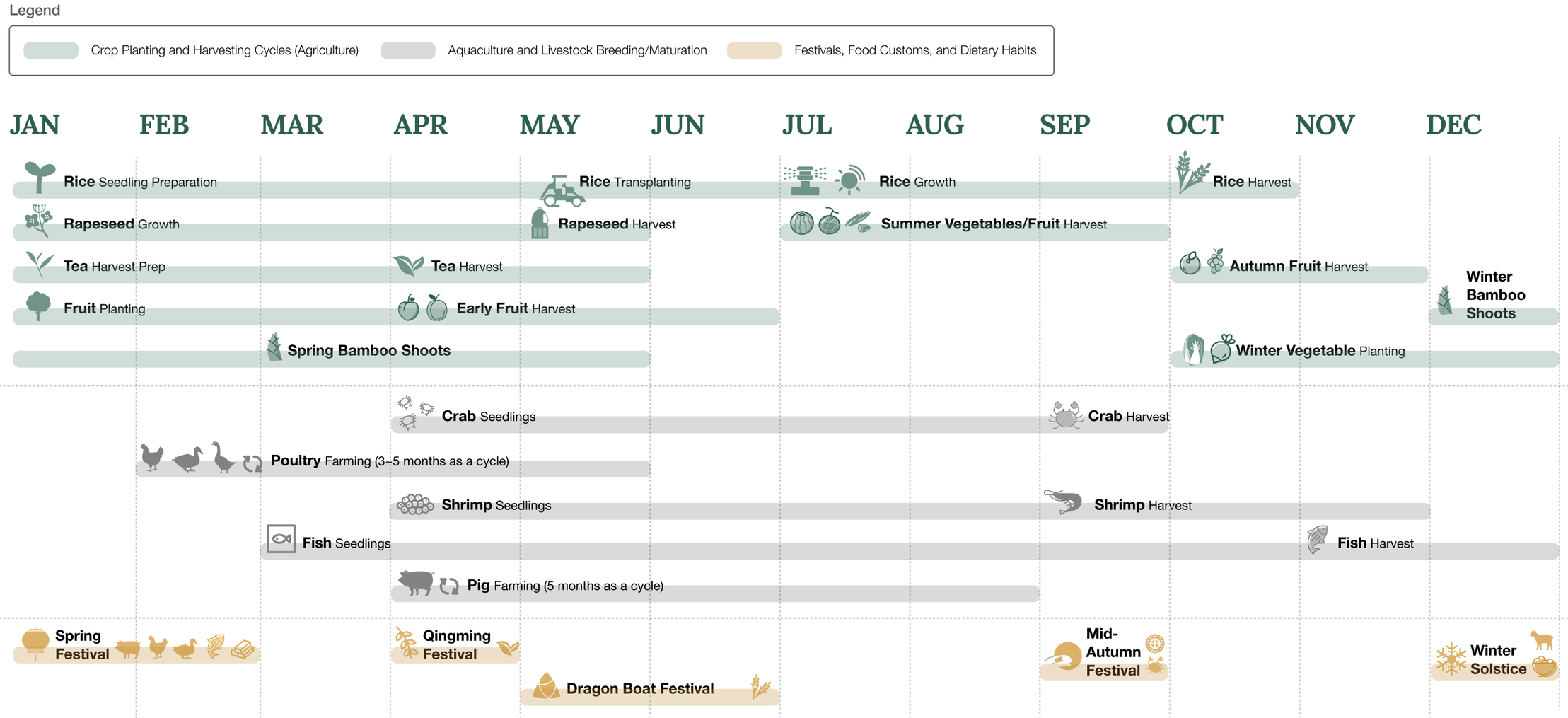
(figure 4.9) Created by the author

Catering styles include traditional local Zhejiang and Jiangsu cuisines,

Sichuan, Cantonese, Hunan, Northeastern, Beijing, and Xinjiang cuisines, and exotic Japanese, Korean, Southeast Asian, and Western cuisines. The form covers buffet, hot pot, barbecue, snacks, fast food, bakery, snail powder, vegetarian food, morning tea, and other types, while street fruit stalls, fish stalls, snack stalls and drink bars, cafes, teahouses, bars and other widely distributed (see ***figure 4.9***), providing a rich scene for the construction of diversified dietary patterns.

The research illustrated timing cycles for harvesting, processing, and marketing local specialty crops by mapping a calendar year of agricultural time (see ***figure 4.10***). This chronotable shows the seasonal sequence of the farming produce during the year, including the crucial moments for farmers or significant family events – traditional Chinese festivals, e.g., Chinese New Year, Dragon Boat Festival, and Mid-Autumn Festival. These

A Yearly Timeline



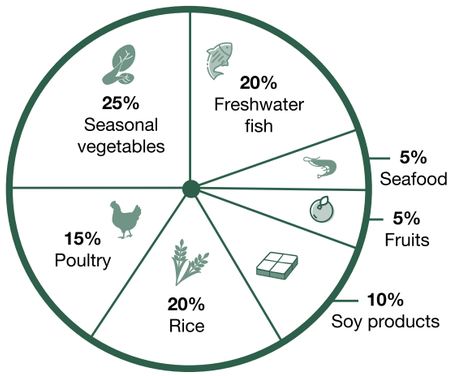
(figure 4.10) Created by the author

cultural nootropic events are not disconnected from certain food ingredients or traditional food consumption, showing the sophisticated interlacing between agricultural fulgurations and their culinary corollaries. Thus, the timeline may be a valuable basis for developing educational interventions related to healthful eating behaviors intrinsic to natural seasonality and cultural practices.

In addition, the research also indicates that traditional Jiangnan food, mainly traditional regional dishes, carries healthy diet practices that agree with modern nutritional science (see ***figure 4.11***). Based on local agri-food resources and cultural habits, such cuisine stresses balancing dishes' freshness and light taste. Fish, shrimps, and freshwater crabs are the protein-rich ingredients; bamboo shoots, lotus roots, and leafy green vegetables are rich in dietary fiber and vitamins. The predominant methods of preparation (steaming, blanching, braising) preserve nutrients while reducing the amount of oil, salt, and sugar. With all these types of food or cooking, Jiangnan cuisine is a perfect example of “low-fat, high-quality off cuisine, and four seasons matching dish,” combining health care with taste enjoyment.

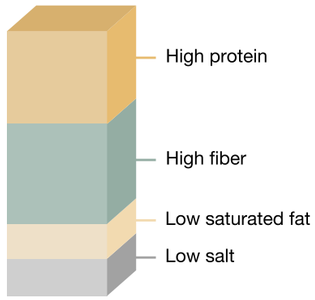
Traditional Dietary Practices

Composition of the Traditional Diet

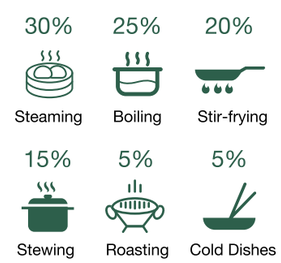


Nutritional Characteristics

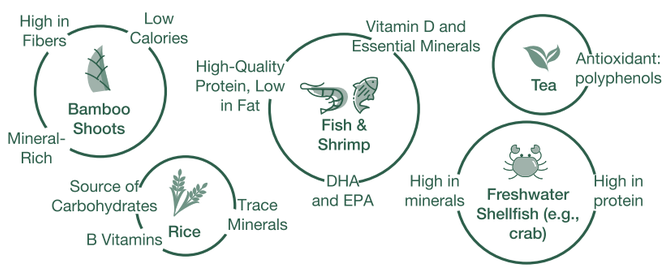
The nutritional qualities of Wuxing District's cuisine are attributed to its rich supply of fish, shrimp, fresh vegetables, and cooking methods that use minimal oil.



Cooking Method



Nutritional Values of Characteristic Foods



Representative Dishes

Cuisine

Originated in the Song Dynasty

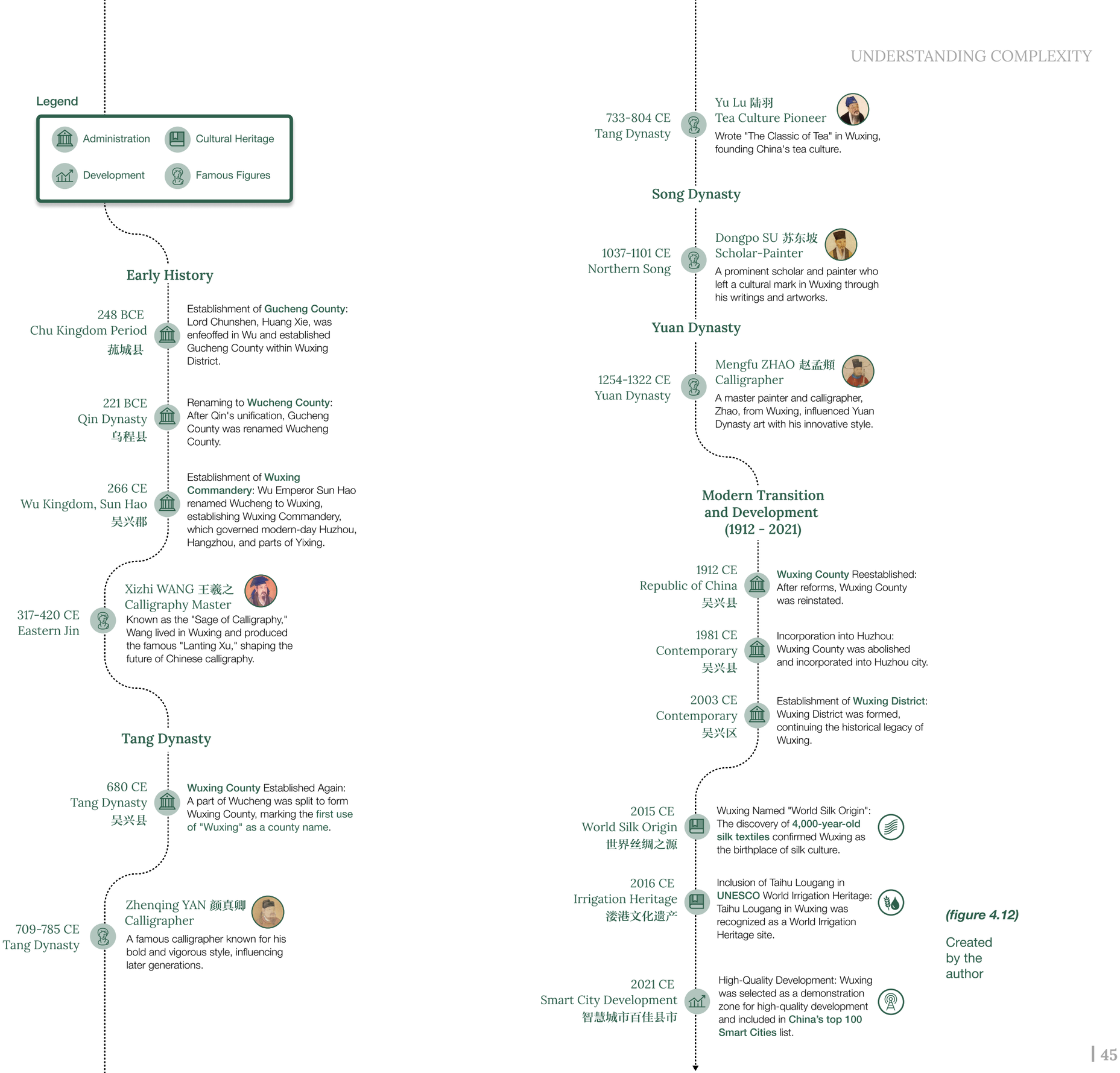
Jiāng 江 Nán 南 Cài 菜

- FRESHNESS
- BALANCE
- SEASONALITY

Dishes

(figure 4.11) Created by the author

Culturally, dietary patterns are not simply what people eat every day — they are woven into the social and historical fabric of the region. The food of Wuxing Reclining Area embodies the regional way of living, also known as TANG CULTURE, which is more or less represented by “refined, intellectual, and artistic.” Historically, the area has been inhabited as far back as 248 BC (see ***figure 4.12***) and contains several cultural sites, many of which still exist. Wuxing is also where many Chinese historical and cultural figures lived, such as the calligraphers Wang Xizhi and Yan Zhenqing, tea sage Lu Yu, poet Su Dongpo, and painter Zhao Mengfu. Their legacies and reputations still define the district’s cultural character, one known for its highbrow literary feel. Moreover, Wuxing is one of the birthplaces of the Four Great Chinese Writing Brushes, with its traditional crafts adding to the cultural landscape. Accordingly, the dietary culture of Wuxing is not independent of its spiritual and artistic culture, and food is the vehicle for historical memory and regional identity.



(figure 4.12)

Created by the author

These cultural and environmental factors provide a sound, locally specific basis for intervention to promote better dietary practices among children. By identifying such interventions in the region's unique cultural identity, traditional foodways, and seasonal agricultural rhythms, interventions can be culturally responsive and ecologically sustainable.

This localized approach not only increases the relevance and acceptability of the message about healthy eating to the child and their family but also connects more deeply to the local environment and heritage, cultivating in the child grounded place-based values behind lifestyle habits.

4.2 | *Understanding the typical school food system in Wuxing District*

This study conducted a systematic and comprehensive diagnosis of the school dining environment in Wuxing District, Huzhou City, Zhejiang Province, aiming to provide data support and theoretical basis for future systematic intervention design to promote the development of sustainable healthy eating behaviors among school-aged children. Located in the core of the Yangtze River Delta on the southeast coast of China, Wuxing District is an area undergoing rapid urbanization, with a relatively balanced urban-rural development, a diversified economic structure, and high population mobility. Therefore, the district is geographically, socially, and culturally representative and suitable as a research object for in-depth analysis of the current school food system, educational structure, students' daily behavioral patterns, and the food preferences and cultural identities behind them.

The study adopted a multi-method data collection approach, including desk research, structured questionnaires, and semi-structured interviews, covering major public educational institutions in Wuxing District (see ***figure 4.13***), including elementary schools, junior high schools, and general high schools. The study collected multidimensional data on the number of schools, student enrollment, teacher-student ratios, and facility equipment and systematically compared and inductively analyzed school food service practices at different educational stages.

Data by 2023

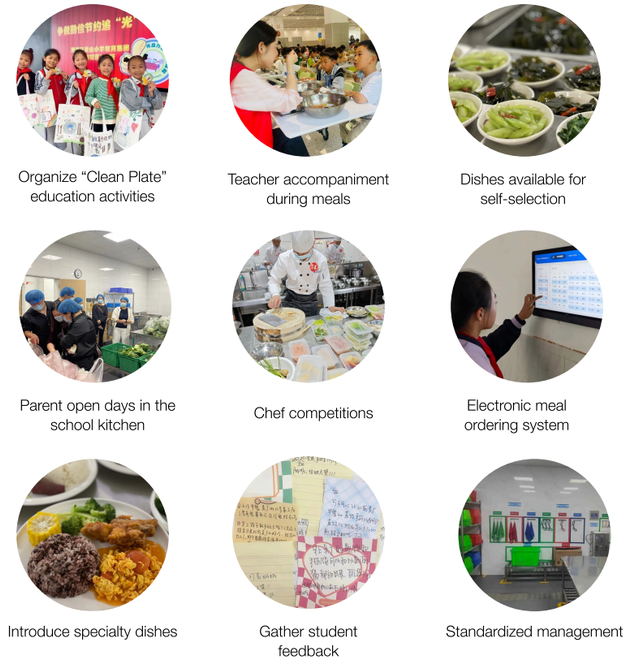
In China, primary and middle schools are part of compulsory education, meaning all children and adolescents must receive free education, and the government ensures equal access and quality across regions.

High schools are part of non-compulsory education, with significant mobility as students often attend schools outside the district.

	School count	Enrollment	In-school students	Teacher count	Teacher-student ratio
Primary School	25	13,210	65,320	3,581	1:18.24
Middle School	21	8,585	23,637	1,778	1:13.29
*General High School	30	14,737	43,315	4,123	1:10.51

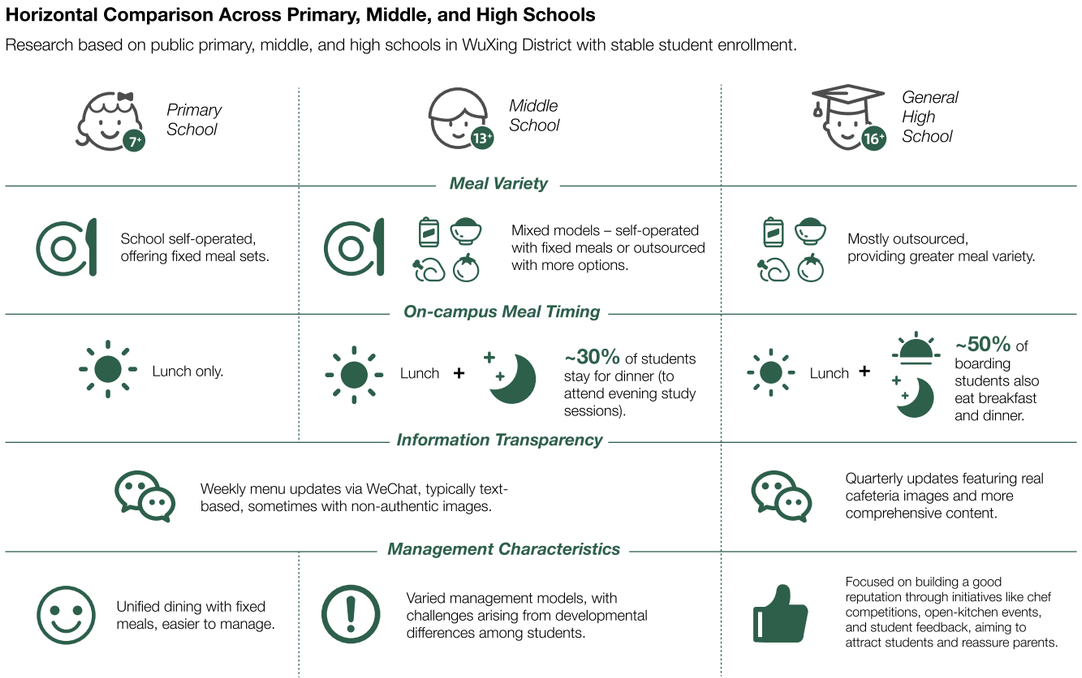
*Data based on Huzhou City, not only Wuxing District

Some schools have taken measures to actively optimize and improve canteen meals, focusing on diversity and nutritional value. The following pictures are from 6 primary schools, middle schools and high schools.



(figure 4.13) Created by the author

As various types of secondary schools show a high degree of diversity in their operating systems, resource allocation, and management styles, this has led to more prominent problems in the practice of school meal systems (see ***figure 4.14***). Especially in the middle school stage, between the ages of 13 and 15, students' physiological needs, dietary preferences, and behavioral habits have entered a rapid change, with significant individual differences. Therefore, designing more precise and individualized dietary interventions for middle school students in this age group is crucial. In this study, we focused on this stage of catering practice and conducted a more in-depth case study and model analysis.



(figure 4.14) Created by the author

In analyzing the daily routine of secondary schools (see ***figure 4.15***), it was found that students' study schedules were relatively tight, with lunchtime concentrated between 11:35 and 13:45, often the only time students could consume a hot meal. Therefore, school lunches should fulfill basic nutritional needs and provide continuous cognitive and physical support for students during intense learning. This study systematically collected and analyzed the weekly menus of four typical secondary schools as a sample and counted the most frequently occurring main ingredients and types of dishes (see ***figure 4.16***). The study found that current diets are highly dependent on common staple foods and protein sources such as rice, green leafy vegetables, tofu, and pork and eggs and that protein and grain intake is relatively adequate. However, the overall diversity of the diets, the degree of seasonal matching, and dietary fiber intake are still significantly deficient.

Daily Routine in Middle School

(figure 4.15) Created by the author

Common Foods in Middle School Menus

After analyzing the weekly menus from four middle schools in Wuxing District, a comprehensive ingredient list was compiled.

Hight-Frequency ●●●●●

Vegetables • Onion • Tomato • Potato • Green vegetables (e.g., bok choy) • Cabbage

Meat and Eggs • Chicken (e.g., wings, drumsticks, fillets) • Egg

Soy Products • Tofu

Staples • Rice

Medium-Frequency ●●●○○

Vegetables • Black fungus (wood ear mushroom) • Shiitake mushroom • Cabbage (Napa or common) • Kelp • Celtuce (stem lettuce)

Meat and Eggs • Sliced beef (e.g., fatty beef) • Pork belly • Pork ribs • Dried shrimp (shrimp skin) • Cured chicken leg • Sausage

Soy Products • Dried bean curd (tofu skin)

Staples • Rice cakes • Vermicelli (glass noodles) • Wheat noodles

Seasonings & Additives • Pickled vegetables • Chestnut

Low-Frequency ●○○○○

Vegetables • Celery • Chinese chives • Bamboo shoots (dried)

Meat and Eggs • Quail eggs

(figure 4.16) Created by the author

In addition, the study highlighted the prevalence of “on-campus convenience stores” and “off-campus mobile vendors.”(see ***figure 4.17***) These venues often sell low-priced, strong-flavored snacks, fried foods, and sugar-sweetened beverages with little nutritional value, which are popular among students and potentially compete with formal nutritional interventions in schools.

In terms of the catering operation system, the study summarized that there are currently three typical service models (see ***figure 4.18***): the first is the self-operated cafeteria model, in which the school manages the cafeteria and develops the menu on its own, with a closed model and standardized processes, but with weak interaction and limited feedback channels; the second is the contracted-out catering model, in which a third-party catering company provides the service, with more choices and a certain degree of

On-Campus Convenience Store & Off-Campus Street Vendors

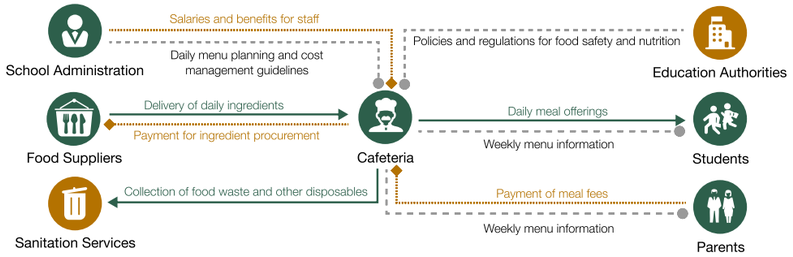
Inexpensive and unhealthy foods, yet carrying childhood memories.

(figure 4.17) Created by the author

feedback mechanisms, but mainly with a top-down management structure, making it challenging to communicate students’ opinions effectively; the third category is the digital reservation system model, which allows students or parents to select dishes in advance through a mobile app, increasing flexibility and interactivity. However, this model still has significant challenges regarding menu diversity, technical support capability, and the degree of cooperation with school resources.

Overall, the secondary school dining system in Wuxing District has a relatively sound foundation in facilities and basic services. However, there is still vast room for improvement in the optimization of the nutritional structure, the integration of cultural content, and the mechanism of student participation. These issues not only provide a practical basis for the systematic intervention design of this study but also provide a pathway and model that can be drawn upon for campus dietary reform in the broader region.

School A:
School-Operated Cafeteria



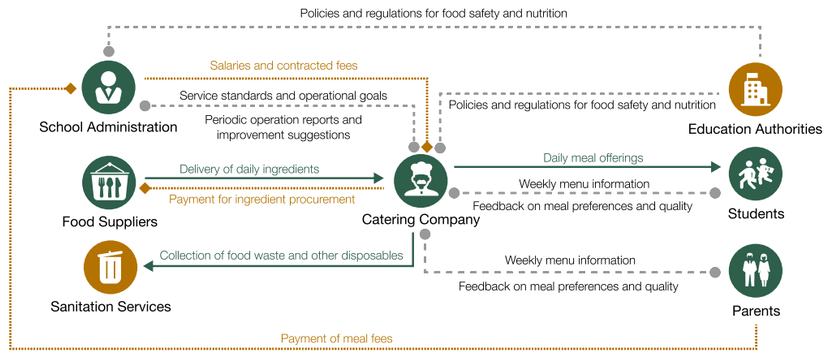
Meal Offering Characteristics:

Limited and fixed menu options with rice and basic meat and vegetable pairings.

System Evaluation:

The system map displays a radial structure, with limited interactions among stakeholders, reflecting a hierarchical and clearly delineated execution system.

School B:
Contracted Catering Service



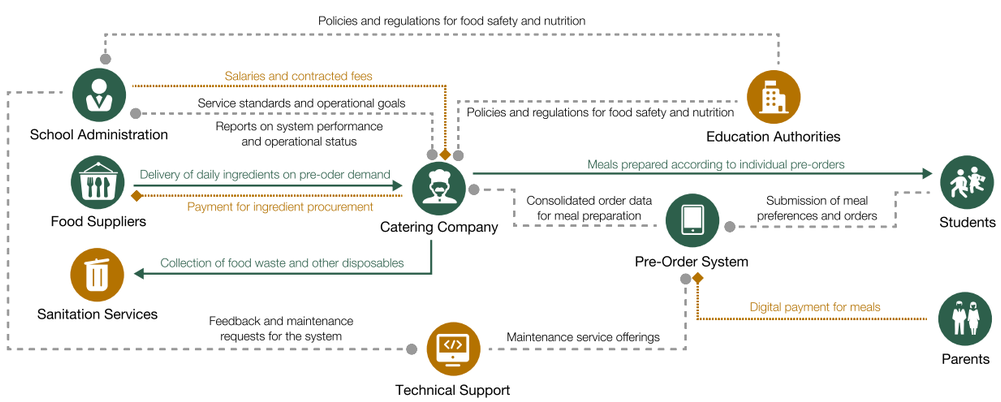
Meal Offering Characteristics:

Offers more variety, including set meals and additional choices to cater to diverse preferences.

System Evaluation:

Some interactions among stakeholders are present, but not extensive. A certain degree of power balance mechanisms exists within this top-down execution system.

School C:
Smart Pre-Order Catering Service



Meal Offering Characteristics:

Provides flexibility and customization, with options tailored to individual pre-orders.

System Evaluation:

Interactions among stakeholders have increased, leading to a shift toward a bottom-up dynamic within the execution system.

(figure 4.18) Created by the author

4.3 | *Understanding the Middle School E campus canteen dining system*

In order to better understand how public schools respond to the conflict between children's healthy dietary needs and sustainable development goals in the context of China's integrated urban-rural development, this study selected a representative nine-year public school in Wuxing District, Huzhou City, Zhejiang Province, as a case study, and carried out a systematic field investigation and process analysis of its campus food service system (see ***figure 4.19***). The school was anonymized as "Middle School E" in the study to comply with the principle of ethical review and safeguard the privacy of teachers and students as well as the objectivity and non-intrusiveness of data collection. In the sample selection stage, this school was the ideal site for this study because of its standardized management, self-operated cafeteria, and complete and representative catering system in the region.

Middle School E is located at the urban and rural areas intersection and has approximately 850 students and 64 staff members. The school insists on providing two meals per day (lunch and dinner), with lunch being mandatory and dinner being open to some students who need to study at night, creating a more flexible meal system. On peak days, the cafeteria serves a total of over 1,100 meals per day. The campus catering system is fully managed by the Logistics Department of the university, which is a self-operated system with no outsourcing and is staffed by 23 cafeteria workers, including purchasers, cooks, caterers, nutritionists, and cleaners. Catering operations are aimed at standardization, and the daily management adopts a multi-level responsibility system and a regular assessment system to ensure the triple guarantee of food safety, nutritional balance, and operational efficiency.

In terms of system structure, the campus catering system of E Middle School can be divided into six core modules: food procurement, food storage and inventory management, meal preparation and cooking, meal service and delivery, meal and feedback collection, and waste treatment and recycling management. These six modules are organically coupled with the process-oriented logic of "Input-Process-Output" to form a closed-loop, industrialized daily operation system, subject to regular review and

supervision by the education administration.

In the first stage - procurement, the acquisition of ingredients mainly relies on two channels: one is the government-certified online procurement platform, which aggregates the resources of compliant suppliers in the region; the other is the direct supply channel for local agricultural products, with priority given to "geographic indication agricultural products" and organic certified suppliers. The second is the direct supply channel for local agricultural products, which prioritizes "geographic indication agricultural products" and organic certification suppliers and strengthens the traceability chain "from field to table." The cafeteria administrator does the procurement process to develop a weekly list of purchases, and the school-level logistics supervisor audits financial records, forming a standardized demand approval path (input). After the arrival of the ingredients, the duty administrator of its freshness, label integrity, batch number, and storage and transportation temperature control data for detailed records to ensure compliance with national food safety norms (processing), and ultimately, the system filed into the electronic database of ingredients to form a detailed, standardized structure of the ingredients inventory list (output), for the subsequent operation of the basis for decision-making. The Wuxing District Education Bureau will send specialists to the school to review the purchase ledger and quality inspection records every quarter to enhance transparency and accountability.

The second stage is the storage and pre-processing of ingredients. The cafeteria has a dry storage room, a low-temperature cold storage room, and a temporary storage area for fresh fruits and vegetables. Each area is equipped with temperature and humidity monitoring equipment and a regular cleaning and sterilization system. After storage, ingredients are categorized and numbered according to frequency of use and shelf life, and the "first in, first out" principle is implemented. At the same time, the chef team carries out preparations such as defrosting, cleaning, cutting, marinating, pre-cooking, etc., according to the meal planner after the daily morning meeting, to ensure a stable rhythm and precise timing of the operation during peak hours.

At the meal preparation and cooking stage, the daily menu is prepared by a full-time dietitian one week in advance, focusing on the variety of combinations and balanced nutritional structure. Typically, each student's

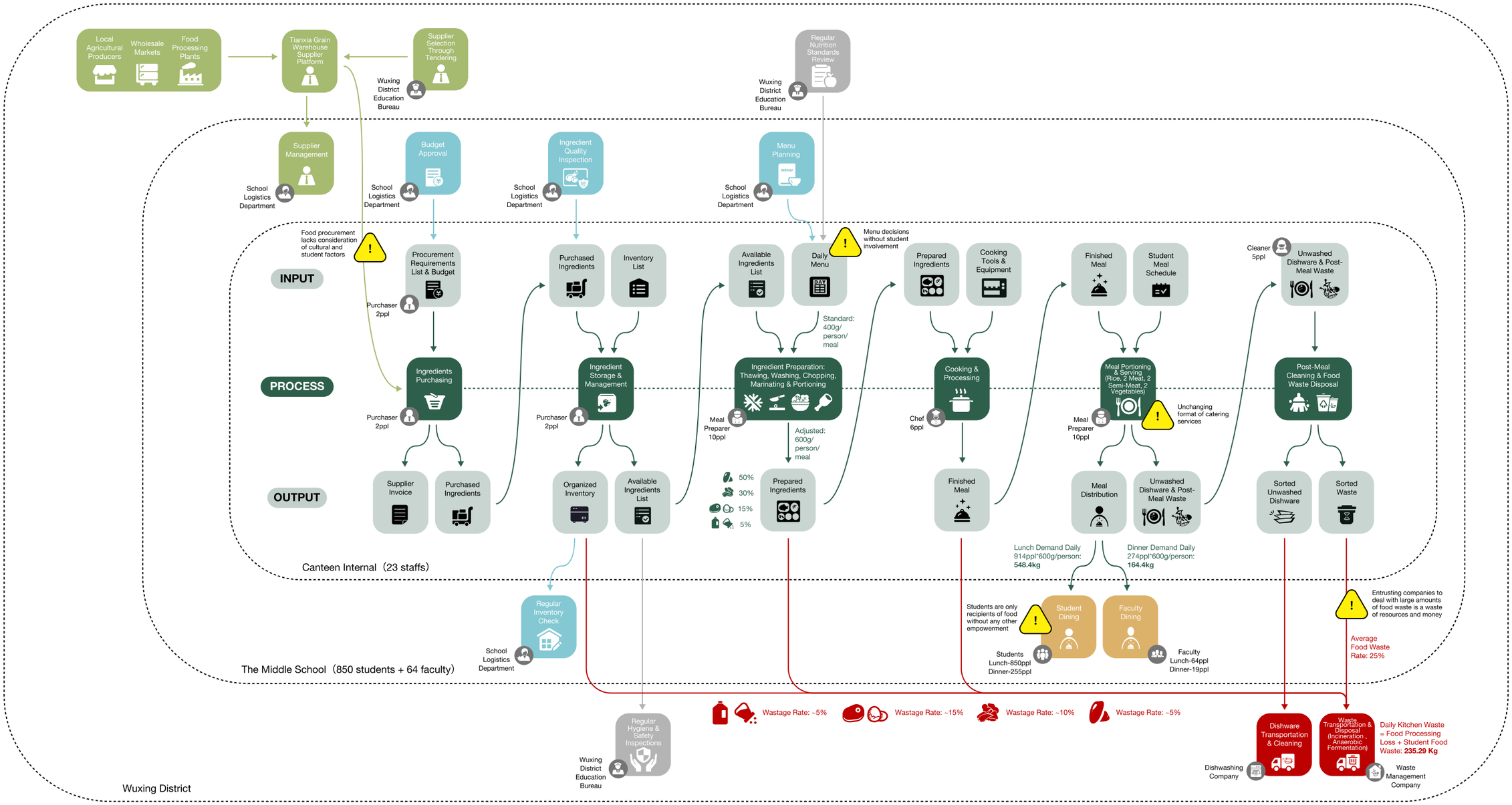
Holistic Diagnosis

Catering System of A Middle School in Wuxing District, Huzhou City

Politecnico di Torino

Systemic Design to Promote Sustainable Healthy Eating for School-Age Children: An Example Based on Urban Areas in Wuxing District, Huzhou, Zhejiang | Benyu Hu

Food Processing
Food Management
Food Procurement
Campus Management
Service Target
Regional Regulation
Waste Disposal



(figure 4.19) Created by the author

standard meal consists of one main course (e.g., rice, rice noodles, noodles), two meat dishes (e.g., braised chicken thighs, pan-fried fish fillets), two half-meat dishes (e.g., tofu stewed with minced pork, scrambled egg with green peppers), and two vegan dishes (e.g., cooled seaweed shreds, stir-fried broccoli). The weight of the standard meal for each student is kept at around 600 grams, requiring about 548.4 kg of ingredients to be prepared during the lunch period and 164.4 kg during the dinner period.

Once the meal is completed, it moves to distribution and dining. The class teacher collects the meal boxes, and the students eat in groups or the designated dining area. Instead of having an open cafeteria, the school adopts a closed meal distribution method to enhance efficiency and management control. About 30% of the students eat dinner at school, mainly concentrated in the sixth grade and above, and the group of students who need to study in the evening. For the teaching staff, there is a separate space for rest and dining. After the meal, teachers on duty assist students in completing the initial sorting of waste, and the cleaning team collects the remaining tableware and sends it to the dishwashing area for high-temperature cleaning and disinfection.

In terms of feedback collection, the school collects opinions on taste, meal temperature, nutritional acceptance, service attitude, etc., through anonymous questionnaires, group discussions, and teacher and student satisfaction questionnaires every month. However, this feedback mechanism lacks a closed-loop implementation path in actual operation - the collected data often stays at the statistical stage, failing to form an effective amendment to the subsequent menu design and operation process.

The last link is the waste management module, one of the weakest sustainability links in the current system. According to observation and weighing statistics, the average loss rate of ingredients during processing is about 15% (e.g., loss from peeling, boning, and cleaning), the physical loss in the delivery process is about 10% (e.g., spoilage and breakage due to delayed delivery), and the waste of leftovers after the students' meal is about 5% (mainly unconsumed dishes and staple food). When these percentages are added, the total daily food waste can reach 235.29 kilograms, accounting for 25% of the raw materials. The school entrusted

This portion of waste to a third-party environmental company for uniform treatment. Common means are incineration or sending to a local biological treatment plant for anaerobic digestion, but the resource efficiency is low due to irregularities in sorting the source.

Despite the high level of maturity and professionalism of the catering system in terms of government regulation, institutional processes, and implementation norms, Middle School E's catering system still faces several structural challenges in terms of sustainability: firstly, the current meal design tends to be standardized and “universal,” lacking individualized responses to the nutritional preferences, allergies, and dietary cultural backgrounds of students; secondly, the feedback and feedback are not always appropriate for students’ needs. Second, the feedback mechanism is challenging to form an actual “information-action” closed loop, resulting in a lack of sustained motivation for service optimization; third, there is a lack of food culture education in the catering process, with students having a limited understanding of the origin of ingredients, the cooking process, and dietary ethics; and fourth, the treatment of waste is not effectively reduced and resourced—failure to achieve the triple objectives of effective minimization, resource utilization, and harmlessness.

In summary, Middle School E, as a case study of a school food system with a complete operational system, transparent data, and clear management, provides a valuable sample for field analysis in this study. Through in-depth analysis of its structure, logic, and daily practice, it can provide a solid foundation for the subsequent design of intervention strategies based on systems thinking and provide empirical support and guidance for the structural transformation of Chinese primary and secondary school campuses from “eating well” to “eating right and eating sustainably.” It also provides empirical support and guidance for the structural transformation of Chinese primary and secondary school campuses from “eating well” to “eating right and eating sustainable.”

4.4 | *User research*

With the core objective of promoting the development of sustainable healthy eating behaviors among school-aged children, this study conducted a multi-perspective user study to provide a human-centered and evidence-based design basis for a systematic intervention program. Based on the systematic design of “multi-stakeholder engagement,” the study focused on four key user groups: junior high school E students, their parents, young teachers, and school administrators, and explored their roles, competencies, needs, and motivations in healthy eating issues.

The study used quantitative and qualitative methods, including structured questionnaires, semi-structured interviews, and secondary data analysis related to the school food system, to ensure a comprehensive and systematic understanding of the different roles’ perceptions, behaviors, and institutional influences. The data analysis is based on the ANA framework (Accolla, 2021), which starts from the Ability, Necessity and Aspiration, to portray the user ecology in depth and to identify structural tensions and collaborative potentials among the roles in order to support the development of design strategies for inclusiveness and equity.

Middle School E students: habits, preferences, and gaps

At the student level, this study conducted a wide-coverage questionnaire survey among junior high school class E students to obtain honest feedback on their daily dietary behaviors, nutritional perceptions, dietary preferences, and value attitudes. A total of 57 valid questionnaires were collected from the four primary areas of “ideal dietary composition,” “school meal experience,” “family dietary habits,” and “healthy dietary understanding and actual behavior.” The four dimensions of “ideal dietary composition,” “school meal experience,” “family eating habits,” and “healthy eating” were used to assess the state of eating behaviors and potential opportunities for intervention. The total score of the questionnaire ranged from -26 to 99 to quantify the maturity of their dietary awareness (see ***figure 4.20***).

The results showed that the overall mean score was 32.25, which indicated that there was a trend that there was more room for

Total score range： -26-99 points

Avg:32.25
H:60
L:-1

-Excellent (80-99 points): 0%
-Good (60-79 points): 1.75%
-Average (40-59 points): 36.84%
-Pass (20-39 points): 40.35%
-Poor (-26 to 19 points): 21.05%

Part 1:
The ideal meal accompaniment
Score range: -18 to 48

Avg:16.34
H:32
L:-10

-High health (30 points and above): 1.75%
-Medium health (15-29 points): 26.32%
-Low health (0-14 points): 42.11%
-Very low health (< 0 points): 29.82%

Part 2:
School Meals
Score range: -4 to 12

Avg:5.78
H:8
L:-4

Excellent (10-12 points): 0%
Good (7-9 points): 12.28%
Fair (3-6 points): 38.60%
Poor (-4-2 points): 49.12%

Part 4:
Understanding and Practicing Healthy Eating
Score range: 0 to 20

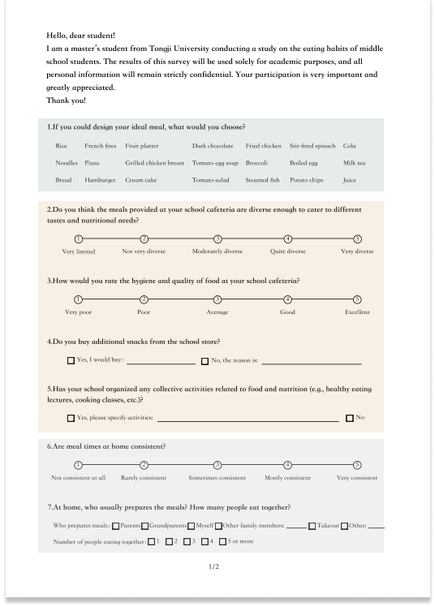
Avg:13
H:16
L:4

Excellent (16-20 points): 3.51%
Good (11-15 points): 59.65%
Fair (6-10 points): 35.09%
Poor (0-5 points): 1.75%

Part 3:
Family Eating Habits
Score range: -4 to 19

Avg:14.26
H:16
L:1

Excellent (15-19 points): 17.54%
Good (10-14 points): 57.89%
Fair (5-9 points): 19.30%
Poor (-4-4 points): 5.26%



Hello, dear student!
I am a master’s student from Tongji University conducting a study on the eating habits of middle school students. The results of this survey will be used solely for academic purposes, and all personal information will remain strictly confidential. Your participation is very important and greatly appreciated.
Thank you!

1.If you could design your ideal meal, what would you choose?

Rice	French fries	Fruit platter	Dark chocolate	Fried chicken	Stir-fried spinach	Cola
Noodles	Pizza	Grilled chicken breast	Tomato egg soup	Broccoli	Boiled egg	Milk tea
Bread	Hamburger	Cream cake	Tomato salad	Steamed fish	Potato chips	Juice

2.Do you think the meals provided at your school cafeteria are diverse enough to cater to different tastes and nutritional needs?
① Very limited ② Not very diverse ③ Moderately diverse ④ Quite diverse ⑤ Very diverse

3.How would you rate the hygiene and quality of food at your school cafeteria?
① Very poor ② Poor ③ Average ④ Good ⑤ Excellent

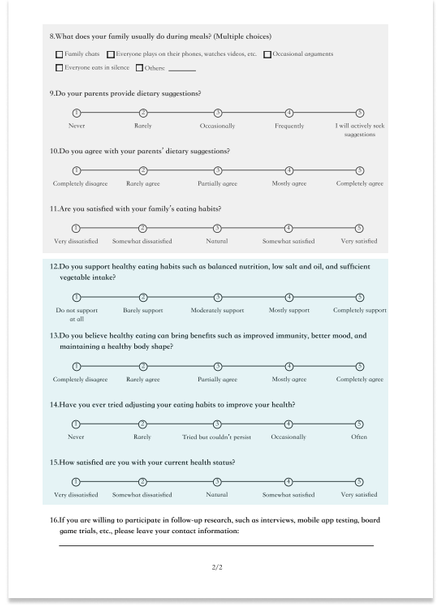
4.Do you buy additional snacks from the school store?
☐ Yes, I would buy: _____ ☐ No, the reason is: _____

5.Has your school organized any collective activities related to food and nutrition (e.g., healthy eating lectures, cooking classes, etc.)?
☐ Yes, please specify activities: _____ ☐ No

6.Are meal times at home consistent?
① Not consistent at all ② Rarely consistent ③ Sometimes consistent ④ Mostly consistent ⑤ Very consistent

7.At home, who usually prepares the meals? How many people eat together?
Who prepares meals: ☐ Parents ☐ Grandparents ☐ Myself ☐ Other family members: _____ ☐ Takeout ☐ Other: _____
Number of people eating together: ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 or more

1/2



8.What does your family usually do during meals? (Multiple choices)
☐ Family chats ☐ Everyone plays on their phones, watches videos, etc. ☐ Occasional arguments
☐ Everyone eats in silence ☐ Others: _____

9.Do your parents provide dietary suggestions?
① Never ② Rarely ③ Occasionally ④ Frequently ⑤ I will actively seek suggestions

10.Do you agree with your parents’ dietary suggestions?
① Completely disagree ② Rarely agree ③ Partially agree ④ Mostly agree ⑤ Completely agree

11.Are you satisfied with your family’s eating habits?
① Very dissatisfied ② Somewhat dissatisfied ③ Natural ④ Somewhat satisfied ⑤ Very satisfied

12.Do you support healthy eating habits such as balanced nutrition, low salt and oil, and sufficient vegetable intake?
① Do not support at all ② Barely support ③ Moderately support ④ Mostly support ⑤ Completely support

13.Do you believe healthy eating can bring benefits such as improved immunity, better mood, and maintaining a healthy body shape?
① Completely disagree ② Rarely agree ③ Partially agree ④ Mostly agree ⑤ Completely agree

14.Have you ever tried adjusting your eating habits to improve your health?
① Never ② Rarely ③ Tried but couldn’t persist ④ Occasionally ⑤ Often

15.How satisfied are you with your current health status?
① Very dissatisfied ② Somewhat dissatisfied ③ Natural ④ Somewhat satisfied ⑤ Very satisfied

16.If you are willing to participate in follow-up research, such as interviews, mobile app testing, board game trials, etc., please leave your contact information: _____

2/2

(figure 4.20) Created by the author

improvement in students' overall dietary awareness and health practices. It is particularly noteworthy that among all the students interviewed, none of them attained the grade of "excellent," and only 1.75% (1 student) performed "good," while the rest of the students were primarily distributed in the range of 'passing' or "poor." The rest of the students were mainly at the "pass" or "poor" level (more than 60%). This data reflects an apparent knowledge-behavior disconnect when students face dietary choices and intervention mechanisms are urgently needed to guide them toward a more positive, autonomous trajectory of health behaviors.

In the "Ideal Meal Design" section, although some students tried to combine vegetables and staple foods, many still added typical high-salt and high-sugar foods such as fried chicken, French fries, and carbonated beverages on their initiative, which showed that their knowledge of "healthy eating" remained at an emotional stage, lacking a systematic approach based on nutritional structure. This shows that their "healthy eating" knowledge is still at the perceptual stage and lacks a systematic understanding of the nutritional structure.

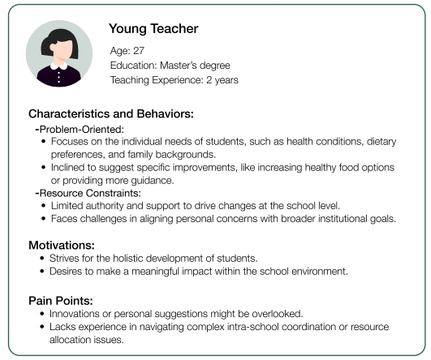
Nearly half of the students (49.12%) rated the "school meal experience" as "poor," and they were mainly dissatisfied with the variety, poor taste, and lack of nutritional content of the meals. This indicates that the current school meals failed to effectively respond to the balance between students' taste expectations and nutritional needs.

In the section on "family eating habits," the performance was more positive, with some students mentioning that "vegetables are the mainstay" and "meals are eaten on time" in their families; some students mentioned healthy behaviors in the family, such as "focusing on vegetables," "eating on time," and "preparing dinner together as a family," reflecting that the family still plays a key role in transmitting health values and has the potential to be mobilized.

However, 59.65% of the students were at the intermediate level of awareness in "Understanding and Practice of Healthy Eating," and only 3.51% were able to transform healthy concepts into self-regulated behaviors. Most of the students lacked awareness of systematic planning of nutritional intake and were more likely to be influenced by taste stimulation, peer influence, and convenience

in their daily choices.

The study showed that students were highly dependent on the meals provided by the school in their dietary behaviors and lacked a sense of participation and decision-making power, which, coupled with the highly structured curriculum and schedules, left little room for them to develop independent dietary management skills. This institutional constraint creates a passive state of nutritional intake and further weakens the basis for long-term healthy behaviors.



(figure 4.21) Created by the author

Teachers and administrators: institutional drivers and friction

Through interviews with two young teachers and two school administrators, we examined schools' internal perspectives and further constructed persona models (see ***figure 4.21***) using the ANA framework (Accolla, 2021).

Young teachers show a strong sense of responsibility and a student-centered approach to education. They are concerned about the differences among students regarding nutritional absorption capacity, eating habits, and family cultural background, and they take the initiative to suggest improvements. For example, they incorporated dietary knowledge into class meetings, provided advice on nutritional initiatives during recess, or advocated the establishment of healthy snack corners. However, in practice, they face several institutional barriers:

- lack of decision-making power on meal content and transparency of information;

- their voices are often suppressed by “administrative efficiency” under the collectivized management system;

- overstepping their authority may lead to unclear responsibilities and other management problems.

Their motivation is centered on the well-being of students and the pursuit of “micro-change” in the educational sense, but these ideals are often difficult to implement due to the lack of appropriate authorization and institutional support.

In contrast, managers focus more on system implementation and the stability of the school's overall operation. They preferred the “steady operation and gradual improvement” strategy and were relatively cautious about introducing new systems or intervention mechanisms. Concerns include:

- the increased cost of handling parent complaints;

- supply chain risks associated with meal reform;

- concerns about the short-term impact on school brand image and sense of order.

While they were not blind to students’ needs, they preferred gradual validation as pilots rather than structural reallocation of resources or behavioral changes. Their motivation is reflected in the dual defense of external image and internal efficiency.

Overall, these two types of educational actors share a certain degree of consistency in their goal orientation (to enhance students' well-being). However, the asymmetry of the power structure and the differences in the assessment indicators lead to significant divergence in their paths of action. This provides a clear challenge and opportunity for designing intervention strategies: how to stimulate the innovative initiative of teachers at the grassroots level without breaking the system’s stability and to induce the management to accept a more adaptive and co-creative reform model.

Parents: domestic influence and practical needs

The study further depicts the

actual mechanism of family influence in shaping children’s eating behaviors through a questionnaire survey of 60 parents of students. The results showed that most parents had strong nutritional awareness and actively participated in health education. However, many constraints still existed at the level of behavioral grounding, constituting a typical discrepancy between intentions and outcomes.

Parents generally possess basic nutritional knowledge and cooking skills and can prepare nutritionally balanced meals for their children when conditions permit. However, the accelerated pace of daily life and the increase in dual-income families often put parents in complex “time/energy constraints,” resulting in a significant deviation from their nutritional concepts.

Parents identified three core needs in the interviews:

- quick and practical healthy recipes or meal replacement programs that can be adapted to busy workdays;

- tools or platforms that can effectively coordinate different intergenerational preferences and dietary concepts;

- supportive mechanisms that can turn health knowledge into daily habits, such as family challenges and behavioral incentives.

Most parents wish to cultivate their children's physical fitness and self-management skills through a rational diet, and they also regard diet as an important medium to promote family intimacy and pass on family cultural values. They aspire to strengthen their interactions with their children through scenarios such as family dinners and parent-child shared cooking, to correct their poor tendencies in school eating, and ultimately to promote the internalization of healthy behaviors into long-term habits.

This study argues that although families already have a good foundation at the cognitive and motivational levels, without systematic support and strategic guidance, it is difficult for individual parents’ efforts to result in behavioral change at scale. Therefore, in the future, we should elevate families from “subsidiary observers” to “active participants” and promote the construction of a collaborative healthy behavior ecosystem through visualization tools and a joint family action platform.

Summary

Synthesizing the findings of the four categories of key players, it was found that achieving promotion and behavioral transformation of sustainable healthy eating in a secondary school setting requires full consideration of the multiple dimensions of institutional, cultural, and capacity influences. Students are characterized by insufficient cognition, dependence, and lack of participation; teachers are willing to educate but lack the space to act; administrators have some institutional practice but tend to be conservative and risk-averse; and parents are in a paradoxical state of positive cognition but limited practice.

Through the analysis of the ANA framework, the congruent and misaligned relationships are identified the congruent and misaligned relationships between multiple actors in terms of needs, capacities, and motivations (see ***figure 4.22***) and further clarified how design interventions can be embedded in a multidimensional collaborative structure. Future systemic interventions should establish synergistic networks, stimulate role dynamics, optimize institutional mechanisms, and promote effective integration between bottom-up practice innovation and top-down strategy transformation to achieve a truly inclusive and sustainable healthy eating transformation.

ANAs Analysis of Target Groups

Middle School Students

Abilities
1. **Basic awareness** of the difference between healthy and unhealthy food.
2. **Struggle to choose** healthy options in real-life scenarios consistently.
3. **Rely heavily** on school-provided meals and family influence for dietary habits.

Necessities
1. **Nutritious, diverse, and appealing** school meals to meet daily needs.
2. Interactive, relatable content that helps **bridge the gap** between knowledge and practice.
3. **Clean, safe** dining spaces and **positive peer engagement** during meals.

Aspirations
1. Feel more empowered to **make healthy food choices independently**.
2. Enjoy meals that are not only nutritious but also **delicious and appealing**.
3. Build habits that contribute to feeling **stronger and more energetic** for studies and activities.

Young Teachers

Abilities
1. **Understand individual student needs** such as health conditions, dietary preferences, and family backgrounds.
2. **Identify problems and opportunities for improvement**.

Necessities
1. **Require coordination and institutional support** to implement effective changes at the school level.
2. **Need resources and authority** to address challenges and align individual concerns with institutional goals.
3. **Seek collaboration with other stakeholders** to overcome resource constraints and streamline efforts.

Aspirations
1. Aim for **holistic development of students**.
2. Strive for **lasting impact** in the school environment.
3. Hope to integrate innovation for **balancing student welfare with school resources**.

School Administrators

Abilities
1. Oversee **school-wide operations** and ensures efficiency.
2. Skilled in managing **reputation** and external relations.
3. Experienced in implementing **pilot programs** and traditional methods.

Necessities
1. Balance **collective welfare** with individual needs.
2. Minimise risks in **policy implementation**.
3. **Reduce friction with younger teachers** while maintaining stability.

Aspirations
1. Maintains **campus stability** and collective satisfaction.
2. Enhances the **school's reputation**.
3. Seeks **practical, low-risk improvements**.

Parents

Abilities
1. Familiarity with **basic cooking skills** and meal preparation for the family.
2. Capable of **adapting recipes** to suit children's preferences and health considerations.
3. Managing **time allocation** for cooking amidst work and household responsibilities.

Necessities
1. Need for **quick and affordable** meal solutions that meet nutritional standards.
2. Support in harmonizing dietary **preferences** of **children, parents, and grandparents**.
3. **Practical guidance** to transform theoretical nutrition knowledge into daily habits.

Aspirations
1. Fosters **family bonding** and communication during meals.
2. **Change unhealthy habits** in children, such as picky eating or buying junk food.
3. **Instill healthy eating behaviors in children**.

(figure 4.22) Created by the author

Tackling Challenges

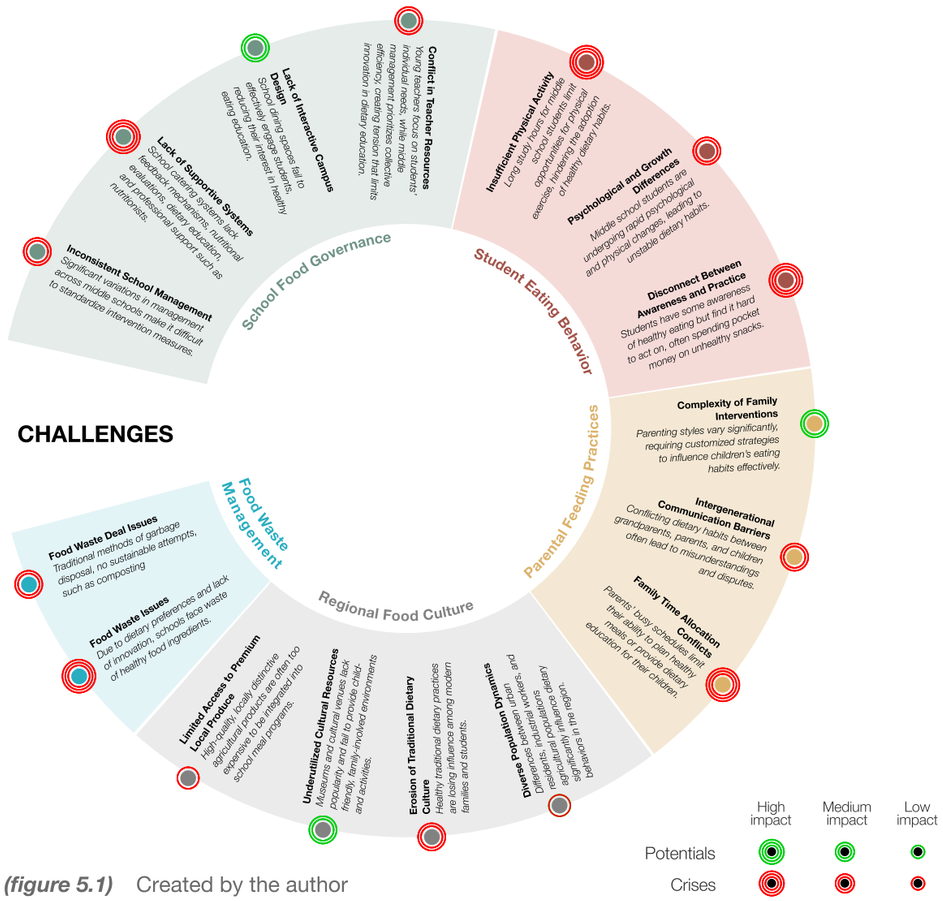
5.1 | *Identifying and classifying challenges*

To effectively address the multiple barriers that prevent schoolchildren from achieving sustainable healthy eating, it is clear that one-dimensional interventions are not enough. We need a structured identification and translation process that systematically reveals the nature behind various types of challenges and transforms them into innovative design opportunities that can provide a practical decision-making basis for subsequent intervention strategies and policy formulation. Therefore, in this phase, a framework approach is constructed to to comprehensively map out the challenges of the school food ecosystem from a systemic perspective, assess the urgency and systemic impact of each issue, and lay a solid foundation for constructing implementable and sustainable solutions by integrating international and local best practices.

In order to comprehensively establish the roots of intervention interventions, challenges were systematically collected and organized from the following key areas: food supply chain and school-based feeding system, school infrastructure development and spatial design, students' eating behaviors, institutional support and educational resource allocation, family engagement, and macro socio-cultural dynamics. Each identified challenge was explicitly categorized as either a "critical" issue, which represents an urgent and far-reaching need to be addressed, or an "emergent" issue, which represents a currently under-addressed issue with potential for future innovation. Potential for future innovation.

Identified problems are into five challenge dimensions, each of which is broken down into several specific problems (see ***figure 5.1***).

1.School Food Governance



(figure 5.1) Created by the author

- Inconsistent School Management: The wide variation in cafeteria management policies, implementation standards, and resource allocation among schools makes it difficult to standardize and scale up interventions, which in turn affects the fairness and implementation of policies.

- Lack of Supportive Systems: Current school feeding systems generally lack key supportive mechanisms, such as feedback mechanisms, dietary and nutritional assessments, dietary education curricula, and systematic support from professionals such as nutritionists.

- Lack of Interactive Campus Design: The lack of interactivity and

immersion in school cafeterias and related eating spaces does not effectively engage students and undermines the effectiveness of the dissemination of healthy eating education.

- Conflict in Teacher Resources: Young teachers are concerned about individualized needs and are willing to promote food education reform, but middle managers are more concerned about collective efficiency and resource stability.

2. Student Eating Behavior

- Insufficient Physical Activity: Heavy classroom workloads lead to severe physical inactivity among students, limiting their possibilities for building healthy dietary habits and affecting metabolism and dietary motivation.

- Psychological and Growth Differences: Middle school students are experiencing rapid growth, accompanied by significant psychological and physical changes that make them susceptible to fluctuating or unstable phases in their dietary behaviors.

- Disconnect Between Awareness and Practice: Although students are aware of healthy eating to a certain degree, they find it difficult to implement it in their actual behavior. For example, they often buy unhealthy, high-sugar, and high-fat foods with their pocket money outside of school, forming a typical dilemma of “Disconnect Between Awareness and Practice.”

3. Parental Feeding Practice

- Complexity of Family Interventions: Family interventions are subject to high levels of uncertainty, and differences in parenting styles (e.g., authoritative, permissive, etc.) mean that “one-size-fits-all” parenting is not practical. Differences in parenting styles (e.g., authoritative, permissive, etc.) mean that “one-size-fits-all” parenting is difficult to achieve and requires refinement and contextualization.

- Intergenerational Communication Barriers: In multigenerational families, conflicts often arise between grandparents, parents, and children over

dietary preferences and perceptions, such as differences in the amount of oil and salt and the choice of ingredients. These differences affect the consistency of family diets and the role of education.

- Family Time Allocation Conflicts: Busy parents’ schedules make it challenging to arrange nutritious meals or sustainably share meals with their children. They may even prevent them from carrying out basic dietary education, which reduces the family’s potential as an educational arena.

4.Regional Food Culture

- Diverse Population Dynamics: Significant differences in the lifestyles and dietary structures of urban residents, industrial workers, and agricultural groups in the region lead to different acceptance of and preferences for “standardized school meals,” creating cultural tension.

- Erosion of Traditional Dietary Culture: Healthy traditional diets have been gradually replaced by modern fast food culture, and students are increasingly inclined to high-calorie and fast-paced dietary behaviors, weakening the influence of traditional dietary education in families and schools.

- Underutilized Cultural Resources: Local museums, agricultural and cultural venues, and other resources lack attraction, especially in the construction of child-friendly and family-involved environments, and they fail to become an important supplement to food education support.

- Limited Access to Premium Local Produce: High-quality local specialty agricultural products are often difficult to incorporate into the school nutritional feeding system due to factors such as high prices and difficulties in logistics and distribution. Thus, the opportunity to promote the mutual benefits of the local food system and students’ health is missed.

5. Food Waste Management

Food Waste Issues: Differences in dietary preferences and a lack of

innovation in meal design have resulted in students' reluctance to consume healthy meals. This leads to a large amount of wastage of healthy ingredients, which is an important manifestation of inefficient resource allocation.

- Food Waste Deal Issues: The traditional food waste treatment method is single-minded, with little sustainable mechanism. For example, there is no composting system or composting program at the campus level, making it difficult to establish a campus food ecological cycle.

To further prioritize actions, we rated each challenge according to its level of systemic impact (high/medium/low), resulting in a multi-tiered matrix of intervention strategies:

High-impact challenges tend to be underlying structural issues, such as the lack of feedback mechanisms for students, a high percentage of food waste, and a disconnect between nutrition policy and local culture. These challenges are the most critical to operational efficiency, student engagement, and long-term impact and should be considered targets for "emergency intervention", prioritizing the introduction of institutional reforms and investment of resources.

Medium-impact challenges represent areas of opportunity that are still in their infancy, such as the motivation of young teachers to engage in food education, the growth of parental interest in food education, and the initial exploration of the use of digital tools to enhance interactivity. If strategically nurtured, these challenges can be important levers for innovation in food education.

Low-impact challenges, while not of significant urgency, provide a testing ground for experimental, context-sensitive innovations. Examples include some parents' low digital literacy and students' interest in culturally specific food not being reflected in menu design. These issues are suitable for a low-risk pilot or long-term incremental strategy that lends itself to cross-border collaboration with community organizations, student associations, niche food suppliers, etc.

Taken together, this structured challenge categorization framework

supports multi-scale prioritization in the design process, helping designers, educators, and policymakers to accurately identify urgent issues that are "most important to address now" and potential "breakthroughs that are worth cultivating. This helps designers, educators, and policymakers identify the urgent issues that are "most important to address now" and the potential breakthroughs that are "worth cultivating" in order to balance the relevance of short-term interventions with the adaptability of long-term systemic changes that will ultimately lead to real and sustainable shifts in healthy eating for schoolchildren.

5.2 | *Opportunity mapping and integration*

Following classification, a subset of the challenges was explored to reveal opportunity points. However, rather than treating each identified issue as its discrete problem, taking a systems-thinking approach that looked for intersections or nodes where one or more leverage points could also address multiple dimensions of the school food ecosystem. This enabled research to selectively identify strategic points for intervention with broad-reaching impact (see ***figure 5.2***).

For instance, rather than just improving the facilities of canteens at school sites, we suggested combining the physical upgrade of campus canteens with digital feedback tools for Student Meals. This not only makes the dining hall a more pleasant place to eat but also enables students to voice preferences and thus increase engagement, closing the supply and demand feedback loop.

Likewise, drawing on family engagement holds great promise for connecting school and home values, behaviors, and expectations. By aligning home meals and school menus, we hope to strengthen consistent dietary messaging, limit conflicting cues, and promote life-long healthy behavior for students.

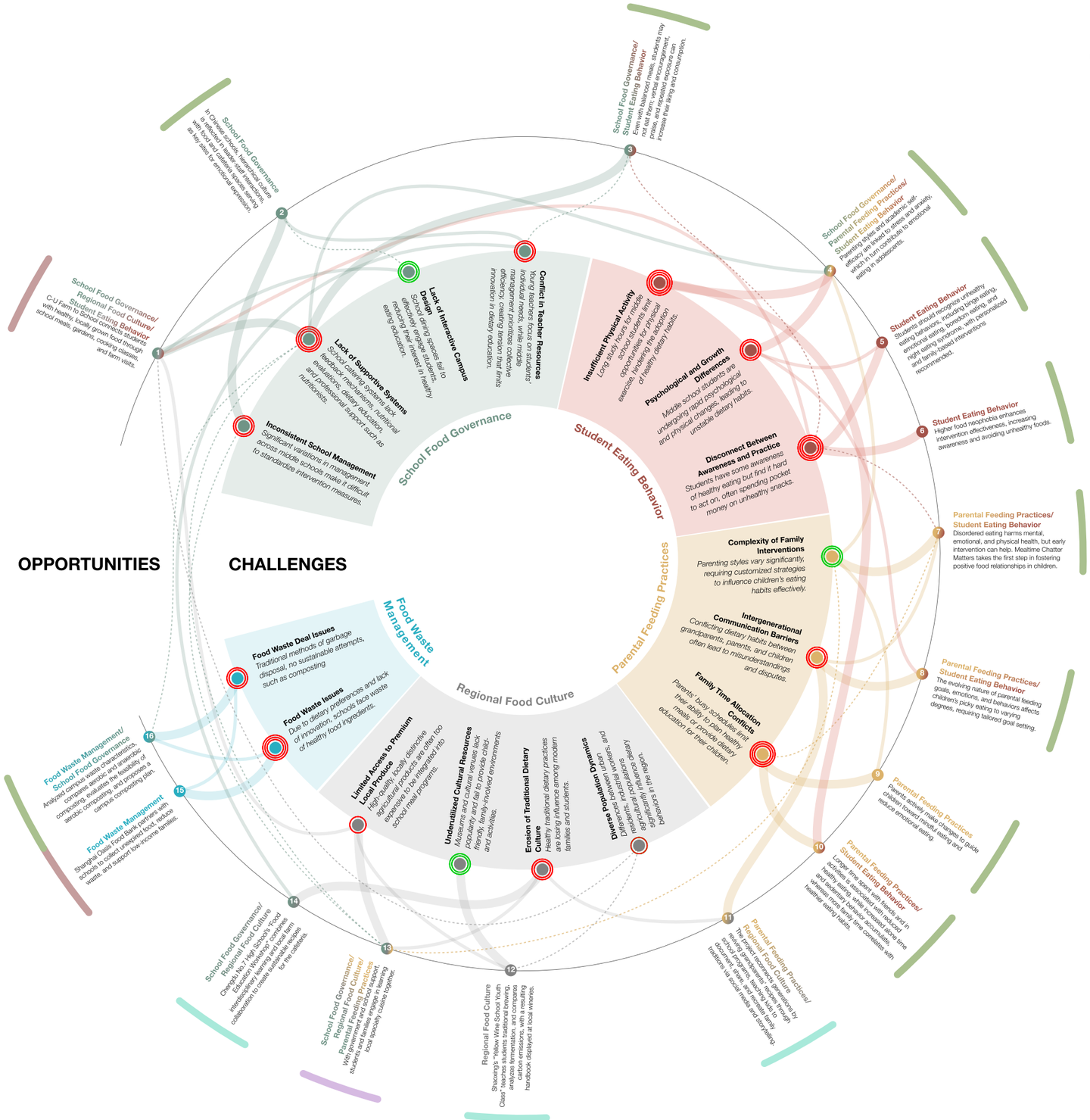
Another multifaceted intervention is creating food waste issues to become student-led awareness or composting campaigns. In doing this, food waste is no longer treated as a management issue but as a learning resource.

Tackling Challenges

Challenges & Opportunities

Politecnico di Torino

Systemic Design to Promote Sustainable Healthy Eating for School-Age Children:
An Example Based on Urban Areas in Wuxing District, Huzhou, Zhejiang | Benyu Hu



GOOD PRACTICES

1. C-U Farm to School, USA
2. Leadership Culture in Education, China
3. Feeding Strategies Used by School Meal Staff
4. Emotional Eating in Adolescents
5. Maladaptive Eating Patterns in Children
6. Intervention Effectiveness
7. Disordered Eating Prevention
8. Fussy Eating & Parenting Patterns
9. Parental Mindful Eating & Child Emotional Eating
10. Adult Supervision, After-School Activity, & Eating in Middle Schoolers
11. Le ricette della nonna: buone ieri, oggi e domani, Italy
12. Shaoxing Rice Wine Workshop, China
13. Kodomo Washoku Sessio, Japan
14. Labor Class of Traditional Food, China
15. Oasis Food Club, China
16. Campus Waste Compost

(figure 5.2) Created by the author

Students measure, analyze, discuss, and ameliorate waste, turning a process issue into a behavioral learning process that has implications for the environment.

To support and take stock of the synthesis above, we drew from a filtered set of 16 best practices (*C-U Farm to School, n.d.*; Wei & Larsen, 2023; Moore et al., 2010; Ekim & Ocakci, 2021; Wildermuth et al., 2013; García-Muñoz et al., 2022; Norton et al., 2023; Wolstenholme et al., 2019; Brantley et al., 2023; Miller et al., 2012; *l'ArcadiLeonardo, n.d.; Shaoxing Cultural Heritage Bureau, 2023; Kodomo washoku session, n.d.; Wanda No. 7 Middle School, 2023; Oasis Food Club, 2023*; Cheng, 2021) spanning the local, national, and international and cutting across event, academic research, service, and policy.

For example, C-U Farm to School brings fresh, locally grown food to students in multiple ways: integrating it into school meals, supporting hands-on garden work, including cooking classes, and organizing farm visits. This project demonstrates how smallholder agricultural systems can contribute to health, education, and environmental goals in tandem *(C-U Farm to School, n.d.)*.

For the Chinese case, Wei and Larsen (2023) show the role of hierarchical cultural norms and order in shaping school interactions. Food and food spaces are emotionally charged spaces that are key yet underutilized conduits for trust, identity, and change.

Moore et al. (2010) highlight that even if nutritionally well-balanced meals are provided in schools, students may not eat them because of taste aversion or lack of familiarity. Yet, verbal encouragement, positive reinforcement, and repeated exposure may slowly improve students' preference for healthful foods, a concept supported by the theory of behavior change signs.

Ekim & Ocakci (2021) and Wildermuth et al. (2013) connect parenting styles with academic pressure and emotional eating in adolescence, suggesting the relevance of tailored family-based interventions to promote healthier relationships with food. They also emphasize certain problem behaviors, such as binging, eating out of boredom, and night eating syndrome, which

are frequently neglected in institutional programs.

Exploiting this, García-Muñoz et al. (2022) highlight that students with high levels of food neophobia—averseness to trying novel foods—may benefit more from targeted interventions, as heightened awareness can stop negative dietary preferences from manifesting.

Programs like Mealtime Chatter Matters (Norton et al., 2023) strive to promote positive emotional associations with food from an early age, emphasizing that shared meals are for sustenance, communication, and interpersonal bonding.

Wolstenholme et al. (2019) point out that parents' feeding styles, emotions, and behaviors are not fixed and can either ameliorate or exacerbate problems such as picky eating in young children. This underscores the importance of tailored family goal-setting in school food interventions.

Brantley et al. (2023) also show how more proactive parents attempt to tailor their feeding styles to reduce emotional eating and promote mindful eating models that may be used in school-based workshops or family-school programs.

Moreover, social context matters. According to Miller et al. (2012), alternate meal locations or more time with peers can decrease healthy food intake, yet more time with family is positively associated with healthy food intake, highlighting the trade-off between socialization and nutrition.

Substantial inspiration can be drawn from several culturally specific interventions. *l'ArcadiLeonardo (n.d.)* re-links generations by reviving grandparents' recipes in schools. Record and replicate traditional dishes, telling the stories alongside and on social media, and developing personal connections to people's heritage.

In Shaoxing's "Yellow Wine School Youth Class" (Shaoxing Cultural Heritage Bureau, 2023), students not only master traditional brewing methods but also interpret carbon emissions from fermentation and complete a student handbook now exhibited in local winery businesses—a fusion of science, tradition, and environmental consciousness.

Community-based learning models such as the *Kodomo washoku session (n.d.)*, *Wanda No. 7 Middle School (2023)*, *and Oasis Food Club (2023)* are examples of how government-school-family partnerships can enable the setting up of local specialty cuisine workshops, transforming food education into an intergenerational, place-based, and participatory experience.

Wanda No. 7 Middle School (2023) highlights that Chengdu No.7 High School Food Education Workshop fosters interdisciplinary study and works with farms to co-create school cafeteria recipes in team form to develop a curriculum with a real-world effect.

By working with schools, the Shanghai Oasis Food Bank collects unexpired food and redistributes it to low-income families to simultaneously address food insecurity and local waste *(Oasis Food Club, 2023)*.

Finally, *Cheng (2021)* looks more in-depth at campus waste streams, comparing aerobic and anaerobic composting and feasibility assessments, and presents a practicable school-based composting program, arguing for integrating sustainability education into day-to-day practices.

This palette of scalable and transferable models consists of best practices. It is their multi-dimensional value that allows them to tackle several problems at the same time rather than one at a time or in silo.

It's a principle of systems design: the most effective interventions are not narrow, technical interventions as such but integrated solutions that can change things and have a ripple effect across interconnected domains. From there, each adversity is seen as not just a roadblock but as a possible pivot, one that can spark systemic change.

5.3 | *Evaluating best practices and constructing an integrated innovation plan*

The next stage in transforming this challenge and opportunity into a viable

action path is to integrate solutions across multiple dimensions into an adaptable and scalable unified framework. Rather than addressing each identified pain point in isolation, we prefer to use an integrative perspective to identify intersections across physical space (such as canteen infrastructure transformation), behavioral dimensions (such as student eating behavior and family involvement), and institutional mechanisms (such as school policies and governance structures) to achieve a more synergistic combination of strategies. This approach responds to the "intervention-feedback-redesign" cycle logic in systemic design and ensures that subsequent services or policies have a lasting impact rather than a one-time fix.

To this end, we further sorted out and systematically reviewed 16 "best practices" from local, national, and international contexts, aiming to provide actionable inspiration for the systemic challenges that this study focuses on. These practices cover successful service projects, community interventions, policy mechanisms in reality, and research-oriented academic achievements with theoretical depth and application potential. Based on their differences in application context, intervention logic, and evaluation indicators, we divide them into two categories (see ***figure 5.3***):

- The upper part of the chart is reality-driven practice cases, which are primarily presented in the form of projects, services, or policies, with clear stakeholders, implementation mechanisms, and time nodes;

- The lower part of the chart shows the intervention logic dominated by academic research. These studies usually provide a theoretical basis, data models, or behavioral intervention strategies, providing long-term and strategic references for real systems.

Since these two types of practices have different starting points in actual applications, their impact paths, replicability, and system adaptability are also different. Therefore, such classification not only helps to evaluate the implementation conditions of various practices more systematically but also provides an evaluation basis for building intervention strategies that adapt to multiple scenarios.

To ensure the systematic and fair evaluation, the research has established

evaluation index systems for different types of practices:

For service-oriented, project-oriented, or policy-oriented practices, we set up five core evaluation dimensions, each of which uses a scoring mechanism of 1 to 5 points:

- Resource Feasibility: Evaluate the feasibility of the practice in terms of resource input, required infrastructure, and human resources allocation;
- Market or Policy Support: Consider whether the practice has gained social recognition, government support, or policy inclination;
- Ease of Implementation: Measure the difficulty of implementing the project in different types of schools or communities;

(figure 5.3) Created by the author

Feasibility and Implementation Priority Assessment

A Scoring System Based on Good Practices – Higher scores indicate stronger current feasibility and constructiveness, while lower scores suggest suitability for later implementation, requiring foundational groundwork first.

		Resource Feasibility	Market/Policy Support	Ease of Implementation	Impact & Scalability	Innovation	Total
SERVICE	School Food Governance/Regional Food Culture/Student Eating Behavior C-U Farm to School, USA	3	3	2	4	3	15
	Food Waste Management Oasis Food Club, China	3	2	2	4	2	13
EVENT	Parental Feeding Practices/Regional Food Culture Le ricette della nonna: buone ieri, oggi e domani, Italy	4	3	4	3	4	18
	Regional Food Culture Shaoxing Rice Wine Workshop, China	2	3	2	4	3	15
	School Food Governance/Regional Food Culture Labor Class of Traditional Food, China	3	3	3	4	2	15
POLICY	School Food Governance/Regional Food Culture/ Parental Feeding Practices Kodomo Washoku Sessio, Japan	2	3	1	5	2	13

		Practical Value	Implementation Feasibility	Target Audience Impact	Long-term Influence	Scalability & Adoption	Total
ACADEMIC RESEARCH	School Food Governance Leadership Culture in Education, China	4	3	1	2	2	12
	School Food Governance/Student Eating Behavior Feeding Strategies Used by School Meal Staff	4	3	3	3	4	17
	School Food Governance/Parental Feeding Practices/Student Eating Behavior Emotional Eating in Adolescents	5	3	4	4	2	18
	Student Eating Behavior Maladaptive Eating Patterns in Children	5	4	5	5	4	23
	Student Eating Behavior Intervention Effectiveness	4	4	3	4	4	19
	Parental Feeding Practices/Student Eating Behavior Disordered Eating Prevention	4	2	4	4	1	15
	Parental Feeding Practices/Student Eating Behavior Fussy Eating & Parenting Patterns	4	1	4	4	1	14
	Parental Feeding Practices Parental Mindful Eating & Child Emotional Eating	3	2	4	3	2	14
	Parental Feeding Practices/Student Eating Behavior Adult Supervision, After-School Activity, & Eating in Middle Schoolers	4	2	4	3	1	14
	Food Waste Management/School Food Governance Campus Waste Compost	4	3	3	4	4	18

- Impact and Scalability: Evaluate whether the intervention can be promoted on a larger scale and produce system-level effects;
- Innovativeness: Determine whether it uses new methods, models, or combinations to solve old problems.

For research-led academic practices, we added five customized evaluation dimensions to reflect their knowledge value and practical potential:

- Practical Relevance: whether the research results have clear application scenarios or transformation mechanisms;
- Feasibility of Translation: the operability of its conceptual model and intervention suggestions in real educational scenarios;

(figure 5.4) Created by the author

From Good Practices to Innovative Action Planning

Drawing inspiration from Good Practices, integrating real-world considerations, and incorporating innovative elements to outline preliminary execution phases and pathways.

Phase 1	Phase 2	Phase 3	Phase 4
The school begins to establish partnerships with farms to support agricultural facilities and education on campus.			
			In later stages, as students and the school develop a stronger sense of responsibility toward food, they start using innovative and effective methods to handle food waste.
An online platform is established to publish information and organize activities (social media accounts – allowing creative freedom, building reputation and influence: Xiaohongshu – school publicity committee: activities announced through posters, updates on campus events, etc.).			
	The school connects with local specialty food industries to help students understand regional characteristics.		
	The school introduces stable labor/family education courses related to food education.		
			A scalable and replicable model is developed, with government involvement for further promotion.
			Interactive designs are implemented in school cafeterias, facilitating exchanges between school leaders, staffs, and students.
	Exposure to healthy food on campus is increased through various methods, such as integrating food-related knowledge into labor classes, putting up posters around the school, increasing the availability of healthy food in cafeterias, and introducing innovative cooking methods.		
Parental education methods and self-learning efficacy influence emotional responses. Visualized educational materials are used to raise awareness of these impacts and are disseminated on campus.			
Common dietary habits that may lead to dependence or addiction and their long-term health effects are identified and visualized for awareness campaigns on campus.			
Highlighting the dangers of unhealthy food serves as an effective intervention method, utilizing visual communication for dissemination on campus.			
	Harmonious family mealtime interactions contribute to dietary health and can be incorporated as an extension of school family courses. Card-based tools can be used to guide students in practicing at home, while parent groups are updated with relevant information to gradually encourage parental participation.		
		Due to the dynamic and complex nature of family environments and the significant individual differences among students, personal measurement scales can be introduced in later stages to customize individual needs and goals.	
			Mindful eating practices at home require parents to already be engaged and supportive of the overall food education initiatives.
			Spending time with friends often leads to consuming junk food, whereas spending more time with family increases exposure to healthy food. Families and friends can establish designated “indulgence days” together.
Campus composting can be the first offline transformation initiative on campus, and it can be promoted through video content on the Xiaohongshu account.			

Target Impact Scope: whether it has a significant effect on key groups (such as adolescents, families, teachers, etc.);

- Long-term Effect: whether it can have a lasting impact on system behavior rather than a one-time response;

- Scalability and Adoption Potential: whether other educational institutions, local governments, etc can adopt it.

Each practice has been given a comprehensive score through the above two scoring systems and mapped them into a four-color-coded phased action framework (see ***figure 5.4***). This four-stage model is not the result of random classification but is systematically arranged based on the following three sets of system variables:

1. Implementation feasibility: whether the practice currently has the foundation for implementation, including resources, workforce, and institutional support;

2. Stakeholder complexity: whether it involves multiple subjects (such as students, teachers, parents, policymakers, etc.) and the difficulty of coordination;

3. System readiness: the psychological, cultural, or structural readiness of the existing system (such as school, community, and family).

The following analysis will interpret these 16 practices in detail according to the classification in the four-stage model and reveal the logic behind their sorting. For example, why are some strategies included in the “quick start” stage while others belong to the “medium and long-term system guidance” stage? This classification method not only helps to plan the priority action sequence but also provides logical fulcrums and timing suggestions for strategy combinations for practical application.

Phase 1 (Red) :
Immediate Feasibility & Quick Impact

Strategies in this phase focus on enhancing student awareness and enabling simple operational improvements within the school’s existing structures. They include:

- Providing students with easy-to-understand health information on social media;
- Sharing daily food education through school digital platforms;
- Running short-term campaigns on dietary knowledge;
- Setting up social media presence for the canteen;
- Student participation in food sharing;
- Involving students in simple composting and food waste sorting practices

These actions require minimal structural changes and can be implemented with existing school resources. They focus on behavioral nudging, communication, and micro-infrastructure, making them ideal for rapid implementation.

Phase 2 (Yellow) :
Building Local Connections

This stage focuses on strengthening relationships between the school, families, and local producers:

- Connecting the school with small-scale local farms;
- Involving parents in lunch menu discussions;
- Integrating student family food preferences into school meals;
- Establishing partnerships between schools and agricultural producers

The strategies here depend on external collaboration and require schools to extend their networks. While more complex than Phase 1, these actions are highly impactful for contextualizing nutrition in local socio-cultural realities.

Phase 3 (Green) :
Deep Engagement & Personalization

In this stage, interventions delve deeper into student individuality, family dynamics, and social behavior:

- Designing personalized dining experiences for students;
- Providing peer support mechanisms through food-based interactions;
- Creating family co-cooking sessions or shared recipe archives;
- Encouraging emotional connections to food through journaling or food storytelling;
- Structuring school events around shared food rituals

These strategies require higher coordination and psychological engagement. They reflect a shift from system-level awareness to

relational depth, engaging students and families emotionally and socially.

Phase 4 (Blue) :
Systemic Diffusion & Cultural Integration

The final phase contains strategies that scale up successful models and extend school practices into the broader community:

- Linking school food education with local museums or public spaces;
- Sharing the school's experience across other schools as a replicable model;
- Involving local artists in school food projects;
- Publishing school nutrition guides or student-designed posters to the public

These ideas rely on institutional maturity, cross-sector partnerships, and visibility. They reflect a systemic vision where the school becomes a larger sustainable culture network node.

In summary, this stage-based grouping method not only provides a clear direction for "what to implement" but also outlines a prototype roadmap for "when to implement" and "how to implement." It helps to set a reasonable pace of advancement according to the maturity and environmental adaptability of different strategies, starting with solutions with low resource

thresholds that are easy to start and gradually transitioning to more structural and far-reaching system-level changes. This planning method not only avoids blindness in the promotion of reform but also improves the sustainability and coherence of the overall strategic execution and provides a pragmatic and feasible action guide for optimizing complex campus catering systems.

Designing the System

6.1 | *From strategy to system: mapping the implementation roadmap*

Building a systematic and sustainable healthy diet ecological path for junior high school campuses is far from enough just to set an idealized target state. The ideal blueprint is important, but the key is to formulate a set of operational implementation plans - a step-by-step, localized, and realistic "implementation path map." This map should not only reflect the current readiness of the entire system, such as the carrying capacity of the system and the adaptability of the school mechanism; at the same time, it must also thoroughly evaluate the enthusiasm and willingness of core participants, such as the attitudes and involvement of students, teachers, school managers, and even parents. In addition, it is necessary to comprehensively consider the existing resource conditions and the maturity of opportunities to ensure that the reform measures are not only "desirable" but also "achievable" and have the realistic possibility of triggering fundamental changes.

This project's implementation path map divides the promotion process into three interrelated and progressive development stages: short-term, medium-term, and long-term. These three stages are not simply arranged according to the timeline but follow a deeper system evolution logic. In other words, each stage not only continues the work results of the previous stage but also shows a trend of gradual expansion and deepening in terms of the complexity of intervention methods, the scope of spatial coverage, and the stakeholders involved. This multi-dimensional growth trajectory enables the entire system to continue to mature and optimize at a relatively steady pace and ultimately achieve a comprehensive transformation from point to surface and from inside to outside.

Taking ***figure 6.1*** as a reference, this path map is like a spiral intervention path: starting from small-scale, low-cost, but highly resonant actions within the campus at the beginning, gradually transitioning to a collaborative network covering families, communities, and local producers, and finally expanding to the embedding and solidification of institutional and cultural levels. Throughout the process, each stage not only laid the cognitive and organizational foundation for the next stage but also gradually accumulated governance experience, trust relationships, and practice models, thus providing solid support for the long-term sustainable development of a systematic healthy diet ecology.

6.2 | *Short-term implementation (month 0–3): building internal awareness and micro-behavioral shifts*

As the start-up phase, short-term implementation emphasizes small-scale, highly symbolic, clearly behaviorally oriented interventions that can quickly resonate with low resource costs. These actions are mainly focused on the campus, using the school's existing platforms and resources, and are jointly initiated and promoted by existing internal members—students, teachers, and administrators—to promote a series of "quick win" action strategies.

Key interventions include:

- Using campus digital platforms (such as the school's WeChat public account, student forums, etc.) to publish visual and engaging food education content;
- Set up food topic columns on school social media or community accounts to encourage students to participate in content co-creation;
- Promote visually impactful poster campaigns to emphasize fundamental concepts such as garbage sorting and food selection;
- Support student-led small "food sharing stations" or "campus composting corners" to transform behaviors into specific and visible campus daily routines.

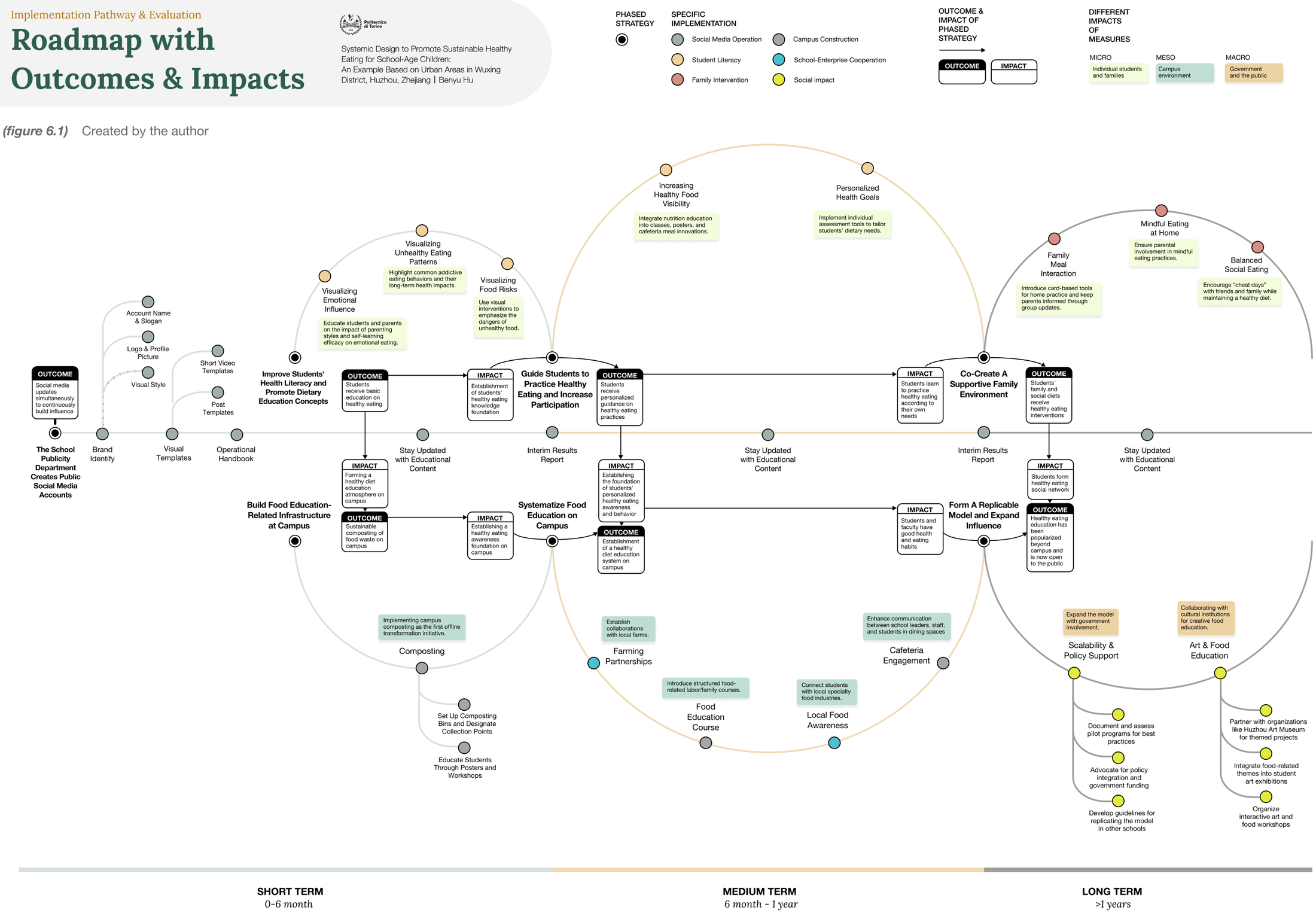
Implementation Pathway & Evaluation

Roadmap with Outcomes & Impacts

Politecnico di Torino

Systemic Design to Promote Sustainable Healthy Eating for School-Age Children:
An Example Based on Urban Areas in Wuxing District, Huzhou, Zhejiang | Benyu Hu

(figure 6.1) Created by the author



These interventions usually do not require external cooperation or major adjustments to the existing institutional framework and are easier to carry out quickly. They play a role in “breaking the ice” and “building momentum.”

Expected outcomes include:

- Initial improvement of students’ food knowledge and health awareness;
- Spontaneous demonstration of the effect of eating behaviors among peers;
- Forming some micro-participatory daily campus behaviors (such as waste food classification and food photo check-in);
- Achieving high visibility at a very low cost and forming a preliminary narrative framework.

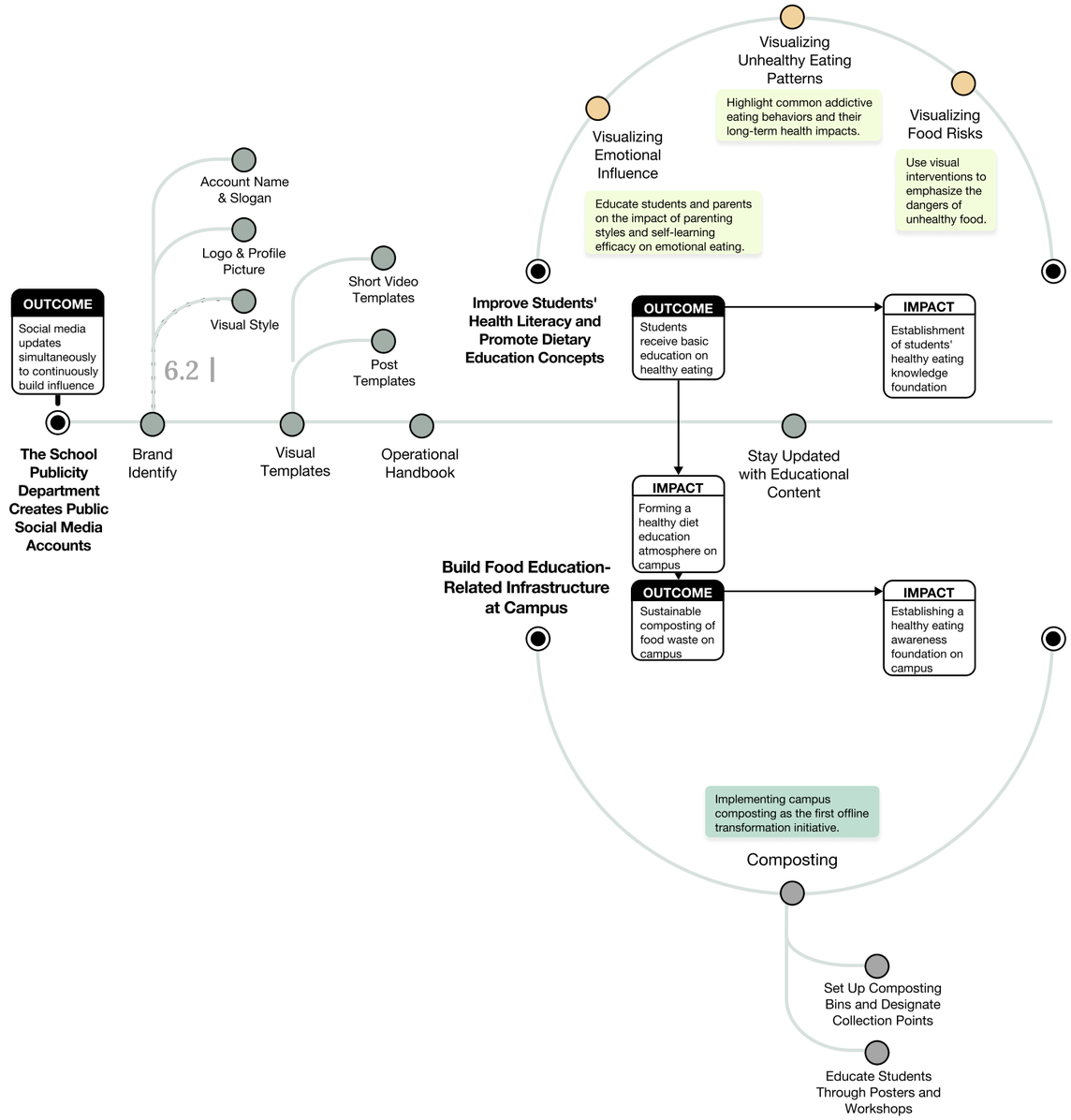
The impact levels are:

- Mainly concentrated within the campus, the target group is students and faculty;
- The intervention method is easy to replicate and has almost no infrastructure threshold;
- Laying the behavioral and cognitive foundation for introducing more complex stakeholders.

6.3 | *Medium-term implementation (month 3–6): expanding toward collaborative networks*

With the establishment of awareness within the system and the start of behavior, the intervention work enters the mid-term stage, when the focus shifts from “internal mobilization” to “external collaboration.” The mid-term stage is characterized by gradually incorporating the school into a wider food relationship network and establishing cooperation with “boundary partners” - such as family members, local small farmers, food distribution units, etc.

The intervention focus at this stage is no longer just information



transmission but to establish a structural and cultural food relationship:

- Invite parents to participate in the design of campus menus to reflect the food culture of different families;
- Encourage schools to organize “family table story sharing” activities to strengthen food memory and intergenerational interaction;
- Establish pilot cooperation with local farms and small cooperatives to promote the “from farm to table” supply model;
- Carry out teacher training or project practice oriented towards “food relationship governance.”

From the perspective of governance logic, this stage marks the transformation of the school’s role from a communicator to an organizer of food relations, with more emotional values and social connections.

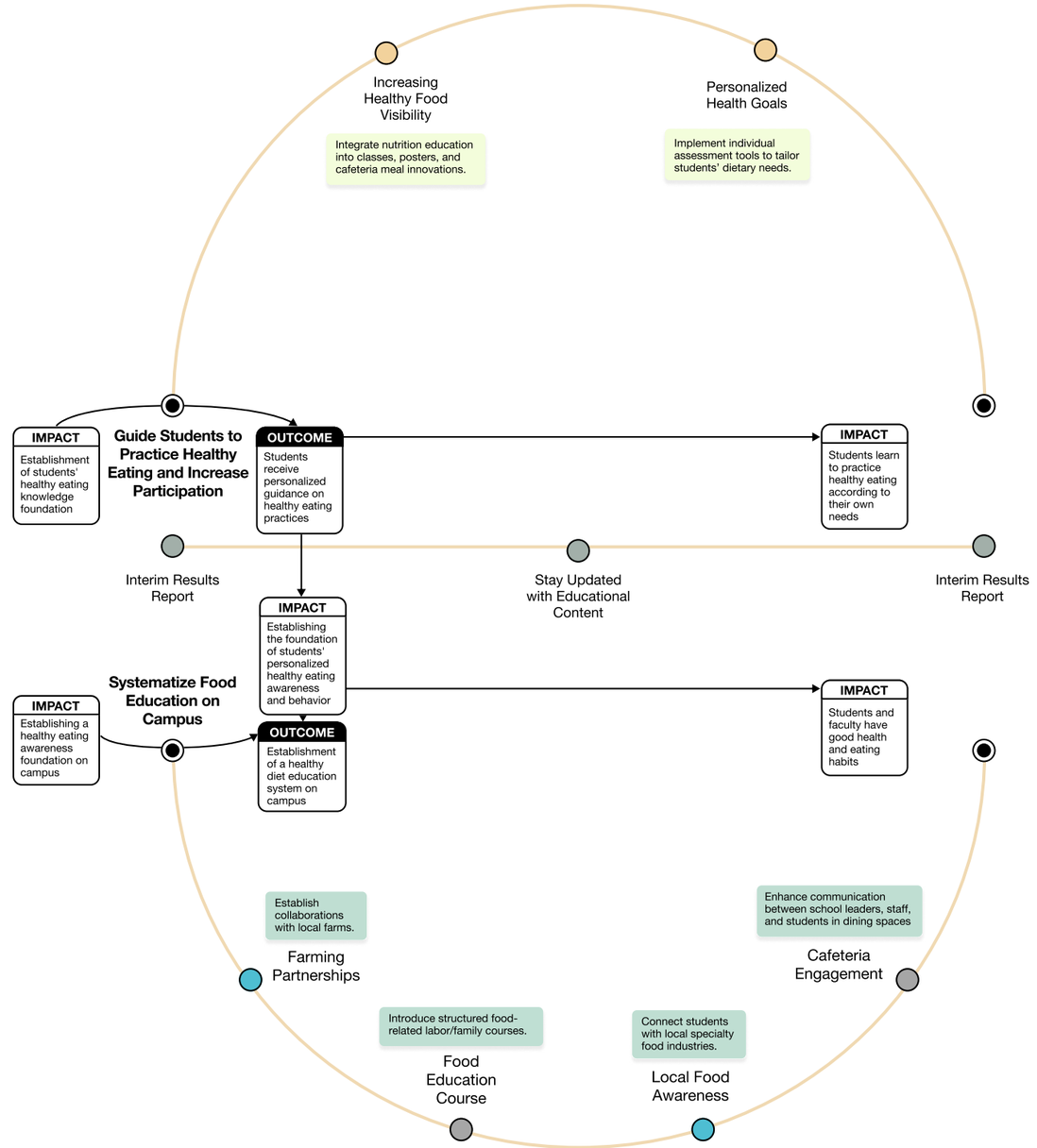
Expected results include:

- Enhance the trust relationship between families and schools;
- Establish a preliminary flexible, collaborative relationship between the campus and the local food production system;
- Reflect more students’ cultural identities and taste preferences in campus menu design;
- Accumulated samples and experience were used to verify the “relational food governance” model.

The impact level is:

- The scope of intervention is extended to the family and community level;
- It is moderately complex in terms of logistics, communication, and coordination;
- It is expected to obtain more stable institutional and social support and has the potential for sustainable expansion.

6.4 | *Long-term implementation (month 6–12): embedding cultural infrastructure and scaling across systems*



Entering the long-term phase, the proven effective interventions in the first two phases will be institutionalized, further embedded in school culture and organizational structure, and disseminated and replicated at a larger system level. The core of this phase is to transform “experience” into “norms” and make campus food education a sustainable, disseminable, and shareable cultural content and institutional infrastructure.

Specific actions include:

- Student-generated content (such as food records, paintings, and short videos) is open to the public through campus exhibitions, parent open days, etc.;
- Establishing cooperation with local museums, cultural institutions, TV stations, or municipal education departments to make schools “food education communicators”;
- Integrating the practical results of the first two phases to develop a reusable “campus food education toolkit” or “action template”;
- Promoting experience exchange and policy pilots between schools to form a higher level of dialogue and institutional support.

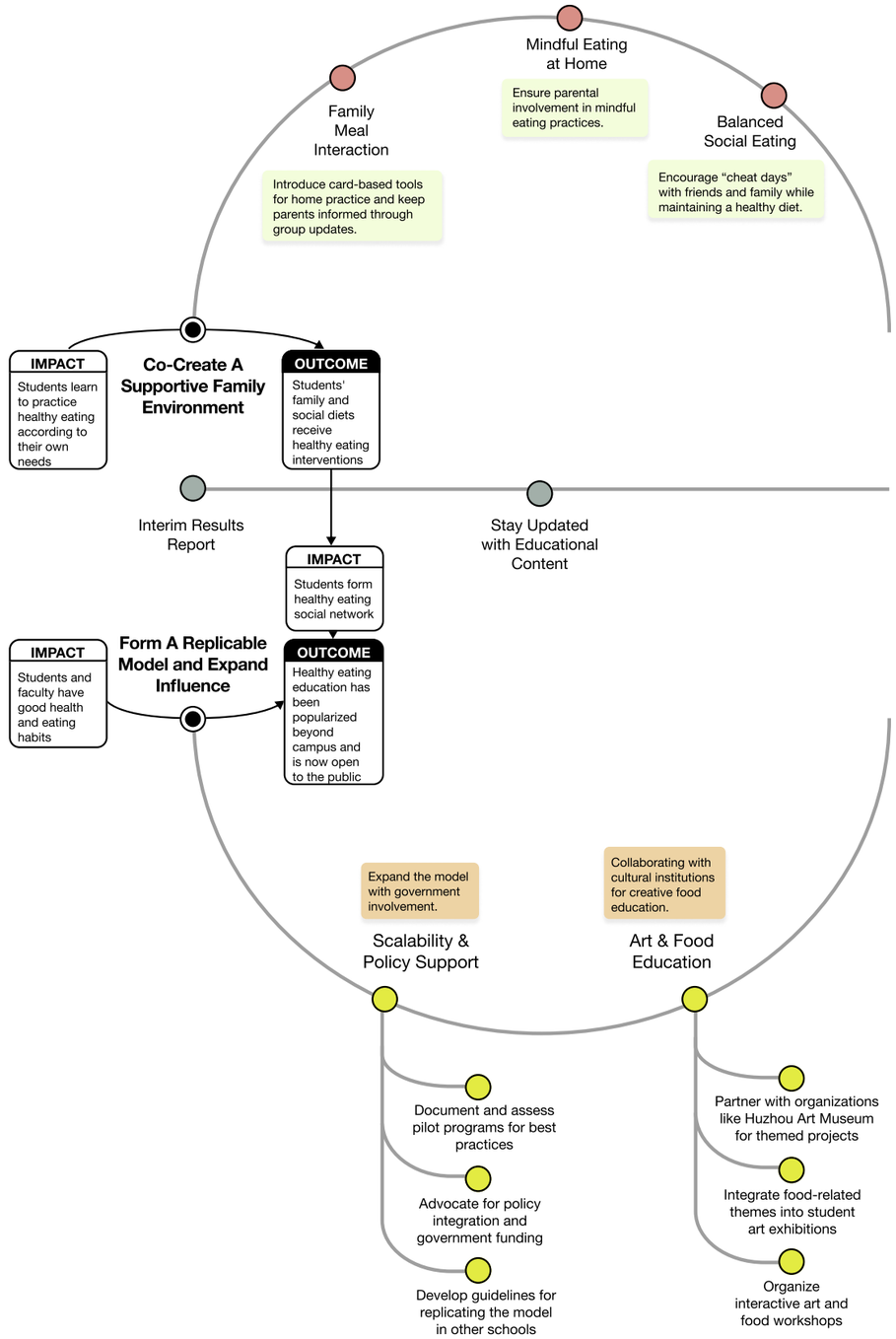
This phase marks upgrading the campus food system from internal governance to cultural construction and public communication, forming a longer-term social impact.

Expected results include:

- Institutionalization and curriculum of food education, becoming part of school education content;
- Horizontal replication and promotion of the model in regions, cities, or larger areas;
- Data and cases based on real experience promote the formation of relevant policy agendas;
- Eating behavior is embedded in cultural identity and daily norms.

The impact level is:

- Having profound cultural resonance in the time dimension;
- Achieving system visibility and communication influence in the spatial



dimension;

- Connecting public health, education policy, and community development issues in the governance dimension.

Developing a healthy and sustainable dietary ecosystem at a school level is not a quick win, but a gradual and cumbersome process that involves thoughtful planning, multi-level coordination, and incremental adjustments over time.

The transition from conventional school meal systems, which are frequently driven by efficiency, towards systems that prioritize health, participation, sustainability, and cultural relevance, not only requires technical change but also substantial shifts in governance arrangements, stakeholder engagement, and institutional values.

In the short term, the first phase of this change process involves activating inner potentials and eliciting enthusiasm among members of the campus community, achieved through low-barrier, high-engagement intervention methodologies.

These are interventions that are accessible, easy to execute, and involve everyone getting involved. This might include, for instance, hands-on workshops on nutrition and food culture, visual campaigns to raise awareness about the theme of food waste, or small-scale test interventions involving students helping to co-create meals.

Through interventions that are highly accessible and engaging, the goal of this stage is to trigger, simultaneously, the curiosity, concern, and potential for action of students and staff. The intention is to create a sense of shared ownership and to initiate behavioral changes on a micro level. It is essential to note that such initiatives pave the way for more formalized and sophisticated management in the future by creating a responsive and knowledgeable internal climate.

In the midterm, after achieving a certain critical level of internal awareness and participation, the transformation extends beyond the school to the

- Connecting public health, education policy, and community development issues in the governance dimension.

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In the midterm, after achieving a certain critical level of internal awareness and participation, the transformation extends beyond the school to the

broader ecosystem of external stakeholders.

This phase focuses on the step-by-step inclusion of families, local communities, health authorities, agricultural producers, and other relevant actors in the construction of a co-governance system. The philosophy behind this expansion is the acknowledgement that eating practices are not established in isolation, but firmly rooted within the family, social, and economic circumstances.

Including items for parents to engage in, such as practicing healthy eating at home, might support parents. Relationships with local farmers and food cooperatives would also help the sourcing of fresh, in-season, and regional products.

These practices are not just about doing things together, but doing together – building trust, shared responsibility, and learning webs. This external orientation ultimately leads to relational governance, in which the school is viewed not as a self-contained entity but as an actor within a larger system with which it is interconnected, characterized by co-creation, joint decision-making, and shared accountability.

This phase aims to co-produce the affected sector and distribute the responsibility for the necessary socio-technical infrastructure for the future.

Long-term: In the long-term phase, the focus shifts to the intention of institutionalization, formalization, and scaling. Carry-on practices, pilot implementations, and innovative initiatives have been refined and tested in the previous phase and are now ready to be evaluated, codified, and integrated into policies.

The integration of successful strategies into school protocols, operating procedures, and curriculum structures can facilitate the continuation of these methodologies, ensuring they are not threatened by personnel or policy changes.

Moreover, the institutionalization process allows alignment with larger systems such as national educational standards, public health initiatives, and cultural development policies.

When adequately described, if not well-documented or evidenced, models and experiences from one school become prototypes for scaling up, transferring, and learning across regions. The value spread at this stage effaces the focus on material upgrades. It propels forward towards the symbolic and enlightenment figure, which supports the notion of food as a locus of cultural significance, environmental stewardship, and civic action.

It is worth stressing that these three periods — short-term activation, medium-term expansion, and long-term institutionalization — do not operate in isolation. Instead, they form an evolving continuum where the first feeds the second, and the second creates the third.

The relationship between these stages is recursive, not linear: the results from later stages can influence and adjust earlier ones, which, together with learning, form a loop that reflects, adapts, and improves.

Both stages act as distributed, independent units of intervention and as cumulative layers that strengthen the knowledge base through learning by doing, stakeholder consensus, and infrastructural capability for the subsequent stage.

In doing so (with this phased and systematic implementation plan in mind), the campus-based culinary transformation becomes both more actionable and contextually informed and socially viable.

This model provides a strategic methodology that is situated somewhere between vision and practical possibility, between strategic foresight and practical pragmatism. It provides practical guidance for schools and policymakers on addressing the challenges of adapting food systems, particularly within educational settings.

The system encourages a food culture that promotes health and well-being, sustainability, social inclusion, and education. This culture influences much more than just what happens within a school gate.

Evaluating the System

7.1 | *Anticipated impact trajectory across phases*

The implementation path proposed in this study not only presents a time sequence of intervention actions but also constructs a predictive picture of systemic evolution. Through the advancement of time and the iterative accumulation of intervention measures, the impact of the intervention is like ripples on the water, spreading from the local to the broader system level. The path map (see ***figure 6.1***) vividly expresses the expansion logic of this "ripple-like impact" through the ever-expanding color block form above the timeline. The core intention it conveys is that even a localized strategy with low resource investment and simple operation, as long as it hits the core node and triggers resonance and feedback mechanisms among participants, may produce a systemic diffusion effect that exceeds expectations in the future.

In the short-term stage (approximately 0 to 3 months), the impact of the intervention remains primarily limited to the campus, with a focus on the individual student level. The key feature of this stage is the "small and beautiful" action: through campus visualization design, digital platform information dissemination, student-led micro-projects, and other means, students' enthusiasm for participation and behavioral awareness is stimulated, thereby triggering initial behavioral changes. Although these actions are small, they are often able to arouse widespread attention in a relatively short period due to their high replicability and intuitive results and become the "trigger" for promoting deeper reforms.

As we enter the mid-term stage (about the 3rd to sixth month), the scope of intervention is significantly expanded and is no longer limited to the school. Family members, small food producers, logistics service providers, and others are gradually being incorporated into the campus food ecosystem,

forming a more complex network of relationships. The core of this stage is "weaving relationships": through measures such as menu co-creation between families and schools, targeted procurement from local farms, and small-scale joint project pilots, the campus food system is promoted to evolve in the direction of greater cultural embedding and institutional flexibility. At this time, the influence is not only reflected in the expansion of the participating population but also the systematic transformation of behavioral patterns, including the diversification of food selection sources, the institutionalization of home-school interaction, and the enhanced linkage between students' food cognition and family cultural identity.

When we finally enter the long-term stage (approximately the 6th to 12th month), the results of the early pilot are gradually institutionalized and incorporated into the school, as well as higher-level education and cultural policy agendas. At this stage, the school is no longer just a service terminal for "receiving food delivery" but has transformed into a regional food education communicator, a cultural co-construction platform, and an incubator of sustainable concepts. The school may engage in cross-border cooperation with museums, urban planning departments, and media organizations, allowing students to present their content, project results, and food practices to a broader public, thereby stimulating external society's attention and investment in youth food education. At the same time, it also lays the foundation for the horizontal replication of experience in the region and the formation of template toolkits and sharing mechanisms. The impact brought about by this stage has three characteristics: cultural legitimacy, communication extensibility, and organizational resilience: it can not only enhance the visibility of schools at the policy level but also form multi-level system impacts at the regional level.

7.2 | *Connecting the roadmap back to the school context*

Although the implementation path constructed in this study has certain versatility and scalability, its starting point is not an abstract theoretical deduction but is deeply rooted in the real situation and system structure of a specific junior high school campus. Therefore, this path map is not only a

time arrangement of a set of intervention strategies but also a practical framework based on real problems and closely related to local needs. During the implementation process, all system interventions must be evaluated and adjusted to ensure they align with the current operating logic, organizational culture, and resource allocation of the campus, thereby making them feasible and adaptable upon implementation (see ***figure 6.1***).

The campus is located in the fringe area of the city, and the family backgrounds of the student groups vary significantly, as does the degree of parental involvement in food education. Most existing food systems rely on unified catering companies outsourced by schools for centralized distribution, offering a single type of food and lacking a feedback mechanism. Although there are scattered healthy diet propaganda and “save food” slogans on campus, students generally lack an overall understanding of the food system, and their understanding of food sources, nutritional structure, and cultural connotations is relatively one-sided.

Based on this situation, this study deliberately matches the intervention measures at each stage with the existing conditions and pain points of the campus when constructing the intervention path. For example, in the short term, a trigger mechanism with strong visualization and interactivity is set up, with campus display boards, digital questionnaires, and student-led menu selection activities as entry points; in the mid-term, family collaboration mechanisms such as “Home-School Dialogue Dinner Day” are introduced to encourage students to bring what they have learned in school back home to achieve soft influence on family eating habits. In the long term, a systematic, sustainable, and scalable institutional arrangement is established through the construction of a campus food culture exhibition hall, the introduction of “Food and Society” elective courses, and the establishment of connections with surrounding farms for cooperative learning.

Therefore, the path map does not exist independently but is an evolutionary tool that is highly dependent on the campus context and is constantly modified by feedback from the campus system. Through the mutual reflection between the path map and the school's daily system, we can more intuitively identify the structural changes brought about by the

intervention action, such as the redistribution of management processes, the reconstruction of teacher-student relationships, and the widening of information flow channels. In the end, the intervention path is not forcibly imposed on the campus as an “external project” but is organically integrated with the original system logic of the campus and promotes the gradual transformation of the system structure through “endogenous adjustment.”

7.3 | *Systemic transformation: from centralized operation to multi-actor participation*

The traditional campus food system usually presents a "highly centralized" operation mode, whose core characteristics are centralized decision-making, opaque information, and lack of feedback mechanism. This linear structure based on “passive supply” makes students and parents have almost no voice and sense of participation in the entire system. Catering suppliers provide standardized food according to fixed contracts, and teachers and students, as "end users," can only passively choose between "eating" and "not eating." This structure may be efficient in the short term, but it lacks flexibility and adaptability, making it difficult to cope with the increasing diversity of dietary needs and food education tasks.

However, as the intervention path gradually unfolds, the system begins to transition to the logic of “multi-participation + feedback drive.” On this basis, a more ecological and flexible campus food system is initially formed. Its main characteristics are:

Diversification of role structure: In addition to the original school and suppliers, multiple stakeholders, including students, parents, teachers, local farmers, food education experts, and community organizations, are incorporated into the system to form a complex yet orderly “actor network.” Each party is no longer just the “receiving end” of the system but a “co-creator” with certain agenda rights and negotiation rights.

Bidirectional flow of information and material: In the new system, not only food is flowing, but also “soft information” such as opinions, preferences,

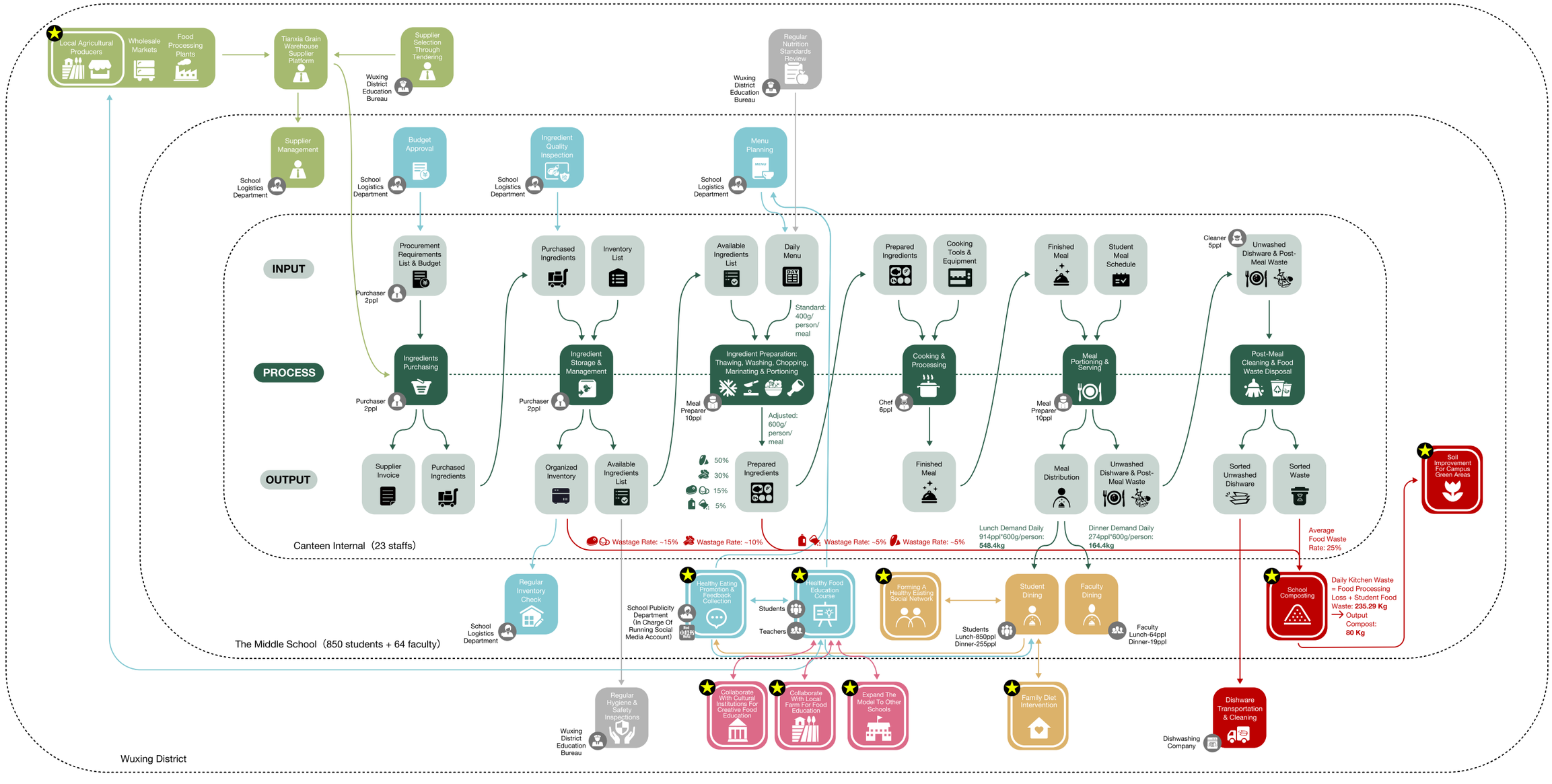
System Map

Catering System of A Middle School in Wuxing District, Huzhou City

Politecnico di Torino

Systemic Design to Promote Sustainable Healthy Eating for School-Age Children:
An Example Based on Urban Areas in Wuxing District, Huzhou, Zhejiang | Benyu Hu

(figure 7.1) Created by the author



suggestions, and reflections is constantly circulating in the system in the form of feedback. Information flows through various mechanisms, including questionnaires, digital platforms, teacher-student interviews, and parent-school meetings, becoming a crucial driving factor in the evolution of the system.

Institutionalization of feedback mechanisms: A series of closed-loop feedback mechanisms are embedded in the reform path. For example, students participate in evaluating lunch satisfaction, regular menu review discussions, post-meal feedback note walls, and fixed-point food waste observation records. These mechanisms not only collect opinions but also make feedback an important driving force for continuous optimization through institutionalized design.

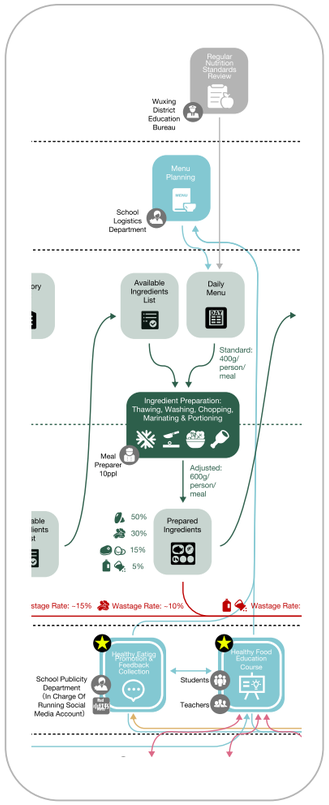
Integration of cultural functions: The new system emphasizes that “eating” encompasses not only nutrition and energy but also culture, identity, and values. The school embeds local solar terms, ethnic food culture, and environmental sustainability concepts into food activities and curriculum design to promote the evolution of the food system into a “cultural community.”

In summary, starting from a one-way transmission, efficiency-oriented “food distribution system,” the roadmap promotes the evolution of the campus system into a complex interactive, collaborative, and co-governed “campus food ecosystem.” This transformation is not achieved overnight, but through phased implementation and node-based triggering, the original centralized architecture is gradually disintegrated, and more flexible space and coordination mechanisms are injected into the system, thus achieving a truly systematic change.

7.4 | *New modules and their functional roles*

Student Media & Awareness Hub

The core design of this module is to create a multifunctional communication platform with students as the primary focus and the school as the foundation to support food education and student value construction. The form of the platform can vary according to school conditions, such as digital whiteboard walls, social media accounts, interactive display spaces, or student-made publications. The common characteristics of these carriers include open, participatory, and sustainable updates, as well as narrative and visual elements. This module serves not only as an information exchange station but also as an educational node for cultivating students’ autonomy, cognition, and participation.



At the operational level, students are no longer just passive recipients of school dietary decisions but actively speak out, share opinions, make suggestions, and participate in discussions and decision-making processes through the platform. For example, students can host a “Menu Reflection Forum” every week to collect dining experiences and taste suggestions from their peers; they can also initiate thematic content creation (such as food knowledge comics, farm knowledge, and healthy diet short videos) through the platform to spread abstract knowledge creatively.

Function:

- Information Dissemination: Transform nutrition knowledge, dietary advice, and food source information into language and media that students can understand.
- Value Formation: Help students develop personal values related to diet, health, and the environment through reflection and expression.
- Narrative Framing: Give students the initiative to control the school food narrative and reconstruct the power structure of “who tells the story.”

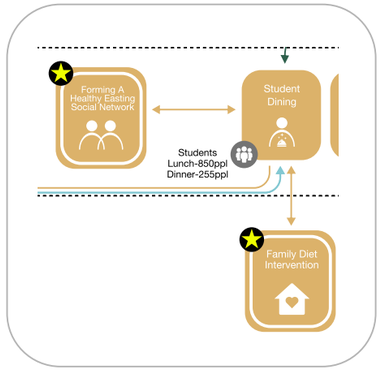
Influence:

- Enhance students' autonomy: Encourage students to question and think critically and establish a sense of subjectivity in the food system.
- Support participatory culture by Promoting a student-centered participation model and implementing a democratic campus decision-making process.
- Promote a family co-design cycle: Let students serve as a communication bridge between the family and school, encouraging family attention and investment in food education issues.

Family Co-Design Loop

This module is committed to breaking the one-way and superficial nature of previous home-school communication and establishing a two-way, multi-level, emotionally connected, and co-creative interface. The platform may be presented in various forms, such as digital applications, food education week activities, and family participation menu design workshops, to encourage parents to participate in the design, improvement, and inheritance of the school food system as "collaborators" rather than "spectators."

Specifically, the platform will design a feedback mechanism to allow parents to provide suggestions and feedback on their children's school meals and also encourage them to share family recipes, seasonal dishes, and eating habits for special festivals, promoting cultural diversity and local adaptability of school menus. In addition, the platform will also host a "Cultural Food Month," where parents will lead cooking demonstrations and share stories to deepen students' understanding of the relationship between food and culture.



Function:

- Cultural Integration: Bring the family's food culture onto campus to make campus meals more diverse and inclusive.

- Emotional Bonding: Utilize food as a carrier of emotional transmission to strengthen the connection between parents and students, as well as between parents and schools.
- External Contribution: Guide families, communities, and professionals to participate in the co-creation process of the school food system.

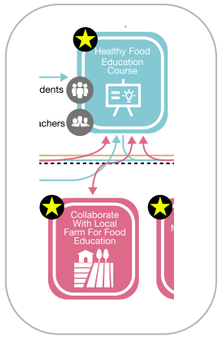
Impact:

- Strengthen cooperation between school and family by promoting two-way trust and information flow and enhancing the interactivity and collaboration of the overall system.
- Contextualize the concept of nutrition: Make nutrition education a practical and internalized concept within the family context.
- Extend learning to the family field: Students apply what they have learned in school to create conversation topics and practical behaviors within their families, promoting the integration of food education across various fields.

Local Farm Partnership Node

This module focuses on reconnecting schools with the front line of food production, establishing a stable and educational local food supply, and developing a learning mechanism. Specific forms include cooperation with nearby small farms, community-supported agriculture (CSA), or organic cooperatives to directly introduce seasonal, fresh, and traceable agricultural products into school cafeterias, as well as design supporting learning activities for visitors.

This not only optimizes the school's food source and supply chain flexibility but also provides students with a real-world learning scenario, enabling them to gain interdisciplinary knowledge and experience throughout the entire process, from production and distribution to transportation, processing, and consumption. Farm visits are conducted through observation, recording, and hands-on operations and are accompanied by classroom discussions and sharing sessions to strengthen students' understanding of food sources and agricultural values.



Functions:

- Food Traceability: Students can understand the source, growth process, and harvest time of each ingredient in their meals.
- Supply Chain Resilience: Reduce dependence on large-scale suppliers and improve system flexibility.
- Educational Connectivity: Connect school courses with real fields to deepen learning effects.

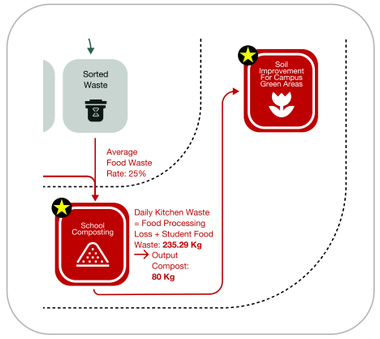
Impact:

- Embed the system into the local economy: Support local producers and strengthen the economic linkage between schools and communities.
- Reduce ecological footprint: Shorten transportation distances, reduce carbon emissions, and improve the environmental sustainability of the food system.
- Strengthen food respect awareness: Let students have a deeper understanding of the labor and resources behind food, thereby reducing waste.

Composting & Waste Management Zone

This module focuses on the “end management” and “resource recycling” of the school food system. Setting up a composting area, clearly labeling waste classification indicators, and implementing student-involved kitchen waste monitoring activities guide students in understanding the relationship between food cycles and environmental protection. In addition to the physical installation, it is more important to focus on educational guidance and behavioral modeling and internalize the abstract “sustainable concept” into students’ daily choice habits through concrete and visual actions

For example, students can take turns serving as “kitchen waste guards” to observe leftovers after meals and record the reasons for their presence. The waste can then be converted into organic compost, used in campus gardens or cooperation with local farms, thereby forming a real material cycle. This module strengthens the closed nature of the system and extends food education to the ecological perspective.



Function:

- Material Recovery: Convert edible waste into reusable resources.
- Environmental Literacy: Enhance students' understanding of natural cycles and ecosystems.
- Behavioral Modeling: Guide students to develop low-waste, high-conscious eating habits through institutional design.

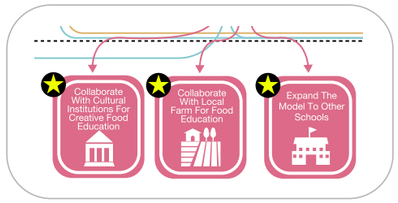
Impact:

- Strengthen sustainable habits: Make “sustainability” not just a slogan but a visible and replicable daily practice.
- Visualize environmental value: Transform abstract concepts such as energy conservation and carbon reduction into concrete results through data display and visual images.
- Cultivate a sense of responsibility and systems thinking: Let students realize the impact of their daily choices on the entire system, thereby enhancing overall environmental awareness and participation.

Cultural Exchange Platform

This module serves as a creative platform that encompasses art, humanities, and social communication, dedicated to showcasing, documenting, and preserving cultural content related to food. It is not affiliated with the school's original teaching system but is characterized by openness and a cross-border nature, inviting external resources, such as artists, designers, and community museums, to collaborate with students in creating food narratives on campus.

These creations can take the form of exhibitions, installation art, visual printing, oral history, short film production, and more, presenting students' diverse imaginations, memories, and emotions about food. For example, an exhibition titled "The Taste of My Childhood" may include hand-drawn hometown dishes, interview recordings, recipe manuals, and visual images. These works not only deepen students' food identity but also build a communication bridge full of stories and resonance for schools, communities, and the public.



Function:

- Cultural Visibility: The cultural implications hidden behind food are revealed in artistic forms.
- Student Voice: Encourage students to express their food memories and identity creatively.
- Public Engagement: Establish a dialogue mechanism with the outside world to allow campus issues to extend into a broader social space.

Impact:

- Promote food as a narrative medium: Endow food with social and cultural connotations, making it a carrier of identity, memory, and value.
- Support long-term cultural inheritance: Through narrative and creation, local and family food culture can be respected and continued on campus.
- Expand the social function of schools: Make schools not just teaching venues but also social nodes for cultural exchange and public engagement.

7.5 | *Redesigned flows and dynamic interactions*

In the redesigned school food system, the overall process and interaction model has been transformed from the original rigid, one-way administrative and supply chain operations to a highly interactive, dynamic network with feedback loops and participation. This design not only emphasizes the openness and accessibility of information flow but also promotes participatory governance and value co-creation. The three key changes are as follows:

- The density of the feedback loop has been dramatically improved

In the traditional model, the school food system often relies on top-down management and decision-making, and students and parents are mostly passive recipients. However, in the new system, the information flow is effectively "sunk," giving students and parents actual control and expression rights over the information. By designing a digital interactive platform, implementing regular feedback collection activities, and establishing a student-centered feedback mechanism, they can gather specific opinions on food quality, nutritional value, and cultural preferences, among other aspects. This information is then fed back to the school administration team and external food suppliers.

Such a mechanism not only makes decisions closer to user needs but also forms a bottom-up "inspirational influence"; that is, senior decision-makers gain insights and inspiration from grassroots voices, breaking the traditional power monopoly and opening up a more democratic food governance model.

- Decentralization of control and node diffusion

The design emphasizes "node-driven operation." Each subsystem (such as the family platform, kitchen, school management department, and local farm partners) is no longer a single execution endpoint but is regarded as a subjective decision-making node. Each node has information feedback and judgment capabilities, and its decision results will not be static at a particular system level but will be immediately transmitted, having an impact that is both visually and interactively apparent.

This allows the system to transition from the previous single-center model (such as the school is the only leader) to a multi-center, interconnected network structure. Each node not only shares information but also shares responsibility and value-oriented decisions. Such a transformation makes the entire food system more flexible and agile while also improving the overall responsiveness to environmental, cultural, and health issues.

- The formation of multi-dimensional flow: beyond the circulation of materials

The new system emphasizes that it is not only the material level of “food” that is flowing but also the expansion of overall system operation to non-material levels, such as value, emotion, narrative, and education. The circulation and sharing of recipes is not only the dissemination of technical knowledge but also contain a cultural value; the classification of kitchen waste is not only the implementation of environmental behavior but also the embodiment of sustainable ethics; and the participation of students and families is not only the output of information but also a social practice of “value resonance.”

This multidimensional flow has gradually evolved the school food system into an “educational ecosystem,” encompassing the dynamic exchange of knowledge, relationships, and emotions and truly implementing the integration of food and education.

7.6 | *Systemic impact evaluation: reach, depth, sustainability*

After embedding the new module, the school food system has evolved from a single-task-oriented, mechanical service architecture to a flexible, multi-level, and socially responsive overall system. Its impact is not only reflected in the improvement of nutrition supply efficiency but also more deeply reflected in the transformation of system design philosophy and the reconstruction of educational implications. We can comprehensively evaluate this system change from the following three aspects:

- Expansion of coverage: from a closed system within the school to a multi-level integrated network

In the past, school catering systems were mostly self-sufficient units, focusing on internal campus operations and internal satisfaction. However, through connections with local farms, families, community organizations, and external cultural institutions, today's system has broken spatial and organizational boundaries.

This expansion not only makes food choices more diverse and menus more representative of regional culture but also makes the campus an “open node” that accepts community co-creation and knowledge regeneration, truly realizing the exchange of education and society. Such a system also has the potential for cross-school cooperation, allowing different schools to share resources and knowledge.

- In-depth improvement: from the supply side to the construction of identity, culture, and values

Traditional food systems are mostly centered on “solving food and nutrition needs,” while the redesigned system shifts the focus to a deeper level of education and culture. Students are no longer just consumers of food but also participate in the construction of food knowledge, the exploration of cultural identity, and the dialogue of multiple values through interactive platforms and learning modules.

For example, parents can share family recipes through the platform, and students can record memories of their grandmother’s cooking. Food thus becomes a medium for narrative, a container for cultural inheritance, and a carrier of emotional memory. Schools have thus become an important venue for promoting “food literacy” and “cultural visibility.”

- Deepening of sustainability: From linear supply logic to circular value chain

Against the backdrop of growing environmental awareness, the redesigned school food system places special emphasis on the overall cycle from resource production and consumption to waste disposal. By collaborating

with local small farmers to introduce traceable seasonal ingredients, establishing composting and kitchen waste classification mechanisms, and guiding students to participate in sustainable actions (such as recording waste and attending farm visits), the entire system gradually forms a closed-loop structure.

This not only effectively reduces resource waste and carbon footprint but also enables students to cultivate sensitivity and practical skills in addressing environmental issues from an early age, making sustainability no longer an abstract slogan but a visible, tangible, and feasible daily action.

Conclusion

8.1 | *Key findings and contributions*

This study aims to systematically explore the nutritional behavior patterns of urban school-age children in China, focusing on Wuxing District, Huzhou City, Zhejiang Province. It uses a systematic design method to reveal the key influencing factors of healthy eating habits and proposes a series of sustainable intervention strategies. Through comprehensive surveys, stakeholder participation design, field observations and prototype experiments, this study presents the following core findings and research contributions:

- A significant gap between knowledge and practice

Although many students have basic nutrition knowledge, this cognition has not been effectively transformed into daily eating behavior. For example, in questionnaires and classroom interactions, most students can correctly distinguish between healthy foods and high-sugar and high-fat foods, but their choices in school meals or family meals are inconsistent. This shows that simply imparting knowledge is not enough to change eating behavior, and deeper factors such as context, feelings and motivation must be combined to guide action.

- The structural role of family and school environment

The family environment, especially the nutrition awareness and eating habits of parents, plays a fundamental role in the formation of children's eating behavior. At the same time, the degree of attention paid by teachers to dietary education, the nutritional structure of school meals and their accessibility also jointly shape students' daily dietary decisions. If parents themselves lack nutritional knowledge or the school's meal plan lacks nutritional diversity and cultural adaptability, it will be difficult for children to establish good dietary habits.

- Age- and development-oriented hierarchical intervention strategies

The study found that considering the cognitive development level and emotional experience of students at different ages is the key to formulating effective dietary education interventions. For example, by sharing food stories, participating in group meals, and exploring local food culture, students' sense of belonging and identity can be aroused, thereby stimulating emotional resonance for healthy eating and promoting lasting behavioral changes. Especially for primary school students, this way of learning through stories and experiences is more contagious and effective.

- Structural limitations of school canteen operation mechanisms

At present, school canteens take efficient supply as the core goal, lack diversified menu design, student feedback mechanism and cultural adaptability considerations, resulting in students' limited dietary choices and a serious problem of food waste, with an average waste rate of up to 25%. This mechanism limitation not only affects the quality of students' nutrition intake, but also weakens the implementation of dietary education.

- Narrowness of institutional collaborative network

Although teachers and parents generally agree on the importance of promoting healthy eating, due to the limitations of the education system, time pressure and communication breakdown, the tripartite collaboration lacks institutional mechanisms and stable support, making it difficult to form a unified and powerful action network. This fragmented support system is not conducive to the implementation and expansion of systematic intervention strategies.

- Innovative contributions brought by the system design method

This study does not only propose a series of point-like intervention measures, but also constructs a comprehensive, collaborative and evolvable action framework through the system design method. The specific research contributions are as follows:

(1) Multi-party co-creation framework design

Based on the ANA model (ability, necessity, aspiration), the intervention strategy is formulated by integrating the participation of key actors such as students, parents, teachers and principals. This widely participated co-creation method ensures the contextual adaptability, cultural sensitivity and sustainability of the intervention plan.

(2) Phased and systematic promotion strategy

The three-stage strategic path of “short-term cognitive activation - medium-term network synergy - long-term cultural integration” is proposed, starting with short-term course introduction and media communication, guiding community participation and family interaction in the medium term, and integrating dietary education into daily life culture through institutionalized mechanisms in the long term, thereby promoting systematic and gradual cultural transformation.

(3) Reconstruction practice of school food system

In the school system structure, multiple functional modules are introduced, such as “student media and cognitive center”, “family co-creation cycle mechanism”, “local farm cooperation network” and “kitchen waste recycling and composting management area”, breaking the linear structure of the previous meal supply process and turning to a participatory, responsive and ecological system ecology.

(4) Multi-dimensional embedding of health, culture and ecological values

This project not only focuses on whether the nutritional intake is “enough”, but also attaches more importance to the cultural construction, emotional connection and ecological responsibility in diet. Under the guidance of design, children can understand the deep relationship between the body, family, community and natural environment through “eating”, so as to naturally develop healthy eating behaviors with a sense of belonging and responsibility.

Through the above practices, this study demonstrates the multidimensional value of system design in complex issues of education and public health, and promotes inclusive, flexible and value-oriented intervention innovation.

8.2 | *Research Limitations*

Although this study has made significant progress in methodological diversity and practical innovation, it is still necessary to truthfully acknowledge the following limitations in order to provide a sound basis for subsequent research:

- Limited geographical scope

This study selected Wuxing District, Huzhou City, Zhejiang Province as the research object, which is an economically developed region in eastern China. The nutritional status of students, school resource allocation and family cognitive level are higher than the national average. Therefore, this result is not suitable for promotion in rural areas, ethnic minority areas or economically underdeveloped areas, and excessive extrapolation should be avoided.

- Lack of long-term tracking and evaluation mechanism

Current research is mainly based on one-time intervention tests and short-term feedback. A systematic longitudinal tracking mechanism has not yet been established, making it difficult to comprehensively evaluate the long-term behavioral changes and psychological impact of the intervention program. At the same time, the ethical approval process and semester time limits also affect the feasibility of continuous observation.

- There are practical obstacles to institutional execution

Although multiple institutional modules have been designed, such as the “family co-creation mechanism” and the “student participation platform”, whether they can truly obtain resource allocation and policy support in the education administration system remains to be verified in practice. The evolution of institutional governance mechanisms often requires time and social consensus, and it is difficult to promote them on a large scale in the short term.

- Ethical gray areas of digital tools

This study recommends the introduction of digital behavioral intervention methods such as “ordering apps” and “social media guidance”. Although they have potential in terms of convenience and data collection, for primary and secondary school students, there is no sufficient research basis for the ethical disputes caused by their guiding behavior (nudging) and screen time, and they need to be handled with caution.

In summary, this study provides valuable insights for the exploration of systematic dietary education, but it also shows that the complexity of this issue still requires continued deepening of interdisciplinary collaboration and empirical research.

8.3 | *Implications for Future Research and Policy*

Implications for research

- Establish a longitudinal tracking mechanism to evaluate long-term impact

Future research should focus on the long-term behavioral, emotional and health change paths of systematic interventions in different age groups, including follow-up evaluations six months, one year and three years after the intervention, to systematically observe the sustainability and value evolution of the intervention.

- Expand to more diverse population groups and regions

It is recommended to conduct empirical research in rural schools, remote ethnic minority areas and economically disadvantaged families to develop a flexible and culturally adaptable intervention model and improve the universality of intervention tools.

- Deepen the integration of behavioral science and digital ethics

The relationship between children’s cognitive development stage, emotional intelligence and digital behavior should be explored in depth to

improve the effectiveness and ethical compliance of digital intervention tools (such as gamified learning and immersive experience design).

Implications for policies

- Institutionally embed systematic food education content

It is recommended that national and local education authorities formally incorporate food education into the compulsory education curriculum system, making it an important part of basic life skills education, and promoting the comprehensive transformation from “nutrition intake” to “cultural construction and ecological awareness”.

- Formulate a tripartite coordination mechanism to connect family-school-community

Through policy mechanisms, encourage schools and families, local farms, NGOs and other social organizations to establish a normalized collaborative network, build a nutrition consensus, spread food culture, activate local resources, and realize the localization and sustainability of food education.

- Fund local pilot projects and promote model innovation

Encourage local education departments and communities to set up pilot programs, conduct local practice and evaluation of systematic intervention models, and support innovative project incubation, cross-regional learning and sharing of best practices through policy funds.

- Redefining the public nature of food: from private goods to public issues

Diet should no longer be regarded as a simple consumption choice, but should be identified as a systematic issue involving public health, cultural heritage and ecological sustainability, incorporated into education policies and urban governance agendas, and build a new institutional foundation for “food democracy” and “children’s well-being”.

Through the deep integration of systematic design and institutional drive, China's dietary education system is expected to move from "eating enough" to "eating well", using food as a medium to inspire the health cognition, self-construction and ecological awareness of the next generation, and jointly move towards a sustainable future that is people-oriented and shared.

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Chapter 1

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Figures

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